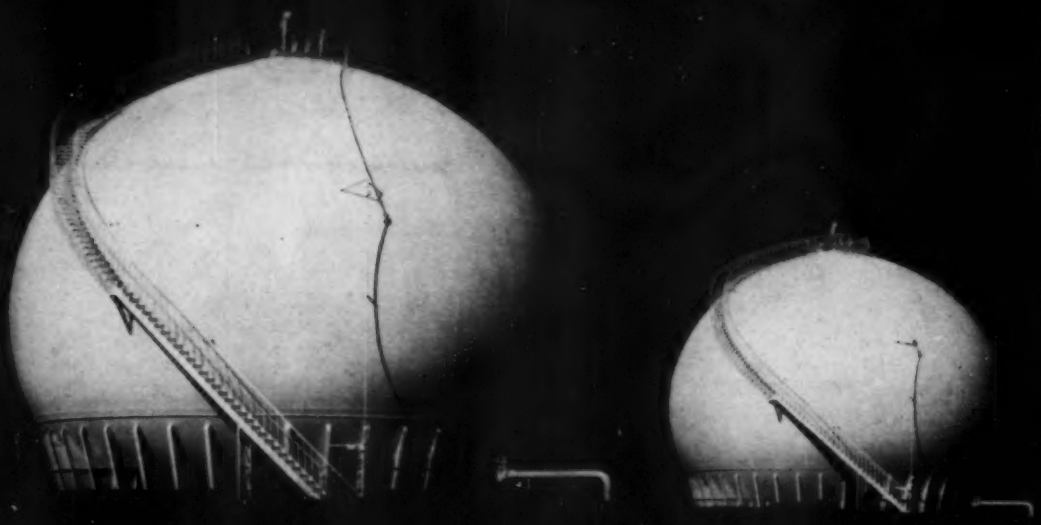
PETROLEUM
APRIL, 1952
REFINER
SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

EVERY DAY—at hundreds of locations—Hortonspheroids are proving their ability to *more efficiently* store petroleum products ranging in volatility from motor gasoline to natural gasoline. Evaporation losses caused by breathing, filling or boiling are greatly reduced, or eliminated all together. That's because the vents do not open and no vapor escapes as long as internal pressure does not exceed the setting of the pressure relief valve . . . The distinctive shape of a Hortonspheroid reduces substantially the weight of the structure per barrel of storage capacity. The plates in the shell, including those in the top and bottom, are utilized more effectively than in cylindrical pressure tanks to resist liquid and gas pressure inside the vessel . . . Plain Hortonspheroids are built in standard capacities ranging from 2,000 to 40,000 bbls. for 2½ to 100 lbs. per sq. in. pressure. Noded Hortonspheroids are built in standard capacities from 20,000 to 120,000 bbls. for 2½ to 20 lbs. per sq. in. pressure.



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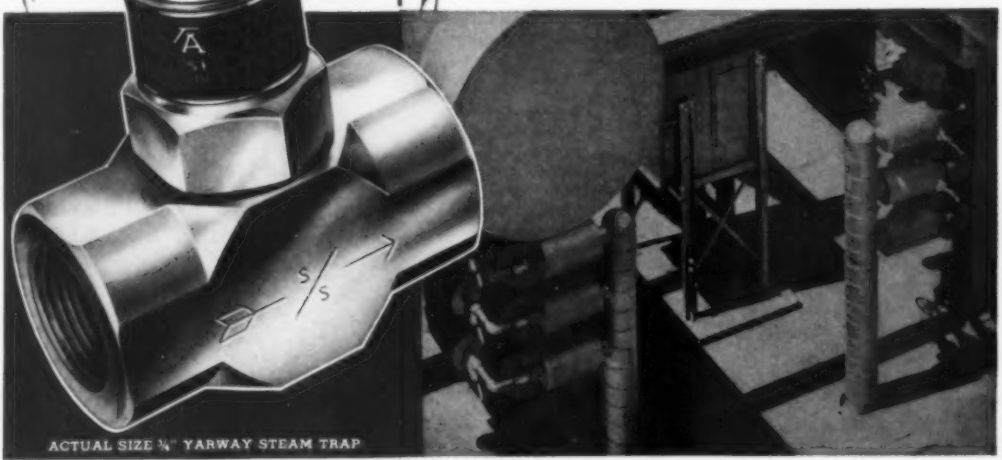

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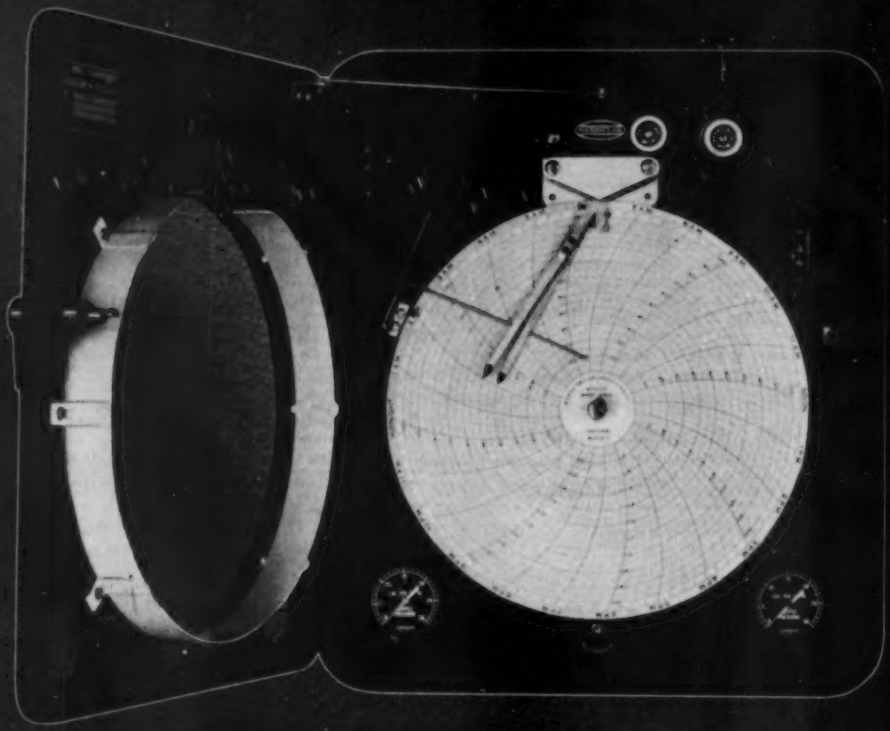
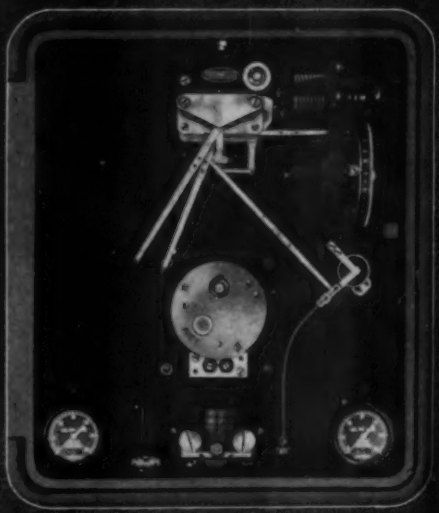
THIS MASONEILAN "6-IN-1"





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Consider the advantages the simplicity of this really modern design offers you . . .

1. ONE MECHANISM — the GIMBAL UNIT — provides four combinations of primary and feedback motion to give you a choice of SIX TYPES OF CONTROL: Direct Proportional; Reverse Proportional; Direct Differential-Gap; Reverse Differential-Gap; Direct On-Off and Reverse On-Off.

2. ONE SETTING selects type of control, type of action and proportional band or differential-gap setting.

3. COMBINATION BACKPLATE-MANIFOLD supports all operational units (plus chart drive and gauges); supports and conceals pneumatic tubing with plug-in connections, which eliminate pressure fittings.

4. Complete, INDEPENDENT operational unit SUBASSEMBLIES — relay pilot, primary element, pen movement gimbal unit, and proportional (or proportional-reset) unit — are *easily* ACCESSIBLE, *easily* INTERCHANGEABLE. Only TWO LINKS are used for connections.

5. SETTINGS (made by knurled knobs and large proportional band wheel) and pilot METERING TUBE are ACCESSIBLE WITHOUT REMOVING CHART.

All types of control plus pneumatic set, time cycle and differential supplementary functions are now available in recording or indicating controllers for pressure, temperature, liquid level or flow service. Also recorders and manual control subpanel.

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To find the one tube steel that's best for you... Ask the experts!

This month's report is on: **SICROMO 2**

Has outstanding surface and structural stability at 1200°F. Has better oxidation and corrosion resistance than 2¼ Cr.-Mo. steel. Recommended for service up to 1200°F. as tubes in cracking coils, reforming units, heat exchangers, vapor line and hot oil piping. Also as return-bend forgings for oil heaters.

23 TIMKEN® STEELS FOR HIGH TEMPERATURE SERVICE

Carbon	Sicromo 2	Sicromo 5S	16-13-3
Carbon-Mo.	Sicromo 2¼	Sicromo 5MS	25-20
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12
Silmo	Sicromo 3	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

*Not available as seamless tubing at the present time.

THERE may be several high temperature steels that will solve your temperature, pressure, corrosion and oxidation problems. But there's only one steel that's *best* for you from the standpoint of maximum tube life per dollar—the best life/cost ratio.

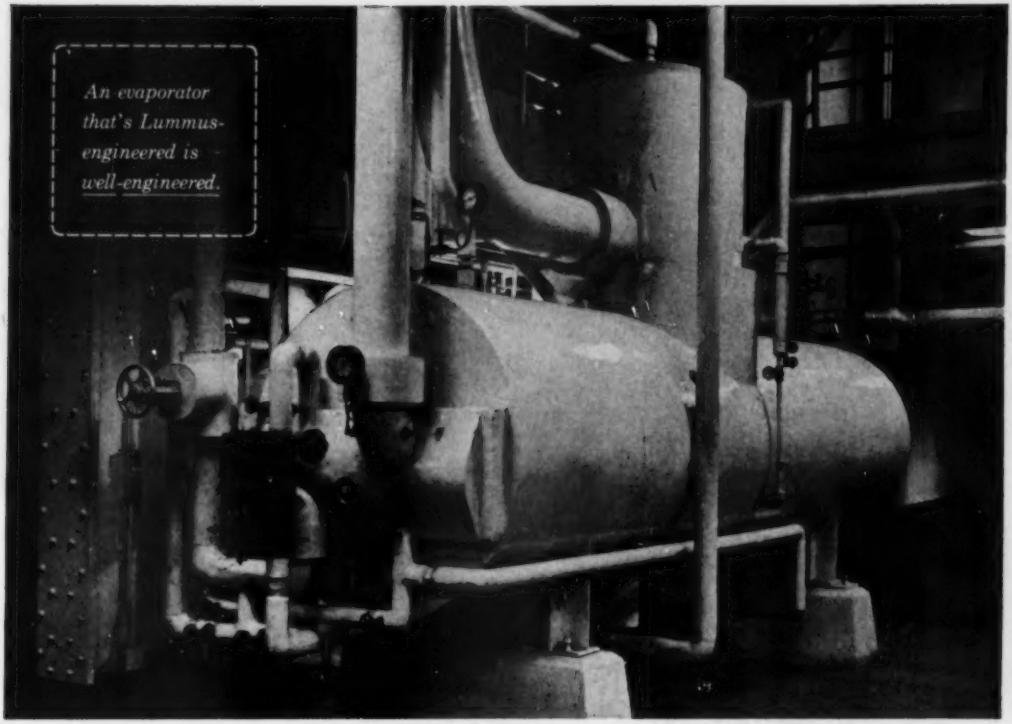
The best way to find this steel is by getting help from the Timken Company metallurgists. They're the recognized authorities on high temperature steels, backed by over 20 years of steel research and experience. And with 23 different analyses to choose from, plus wide field experience, they are qualified to help you choose the correct analysis for your application. Whatever analysis is recommended, you can be sure of uniform quality because the Timken Company rigidly controls quality from the melt shop through final inspection.

Timken's RSQ—Research, Supply, Quality—can solve your tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

Extensive testing is one reason for Timken's leadership in high temperature steels. Photo above shows carbon determination test.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING



An evaporator story that waited 2 years to be told!

Translating requirements into equipment at the time an evaporator is built is one thing. Conducting a field test to check performance after the unit has been two years on the "firing line" is a horse of another color.

The Lummus Bubble Tray Evaporator at Rochester Gas and Electric's Russell Station—shown above—came through such a test with flying colors.

The test placed emphasis on precise determination of vapor purity on a gas-free basis. Results showed that vapor purity did not exceed 0.2 p.p.m. solids content with shell concentration at an average of 2800 p.p.m. for the test period. Of great significance is the fact that this extremely favorable purity remained stable at loads varying from 10% overcapacity down to 25% of design throughput.

This tells its own forceful story of why Lummus can guarantee evaporator performance of not more than 1.0 p.p.m. vapor purity with 3000 p.p.m. shell concentration. It also shows what's available in *plus-performance* when you look to Lummus for your heat exchanger requirements.

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Fully-normalized structure provides uniform ductility for fast, smooth roll-in of ELECTRUNITE Tubes. Cold forming gives them clean, scale-free surfaces that assure maximum service life. Choose from a wide range of sizes and grades, in carbon steel and stainless steel analyses. For complete data and information, write to

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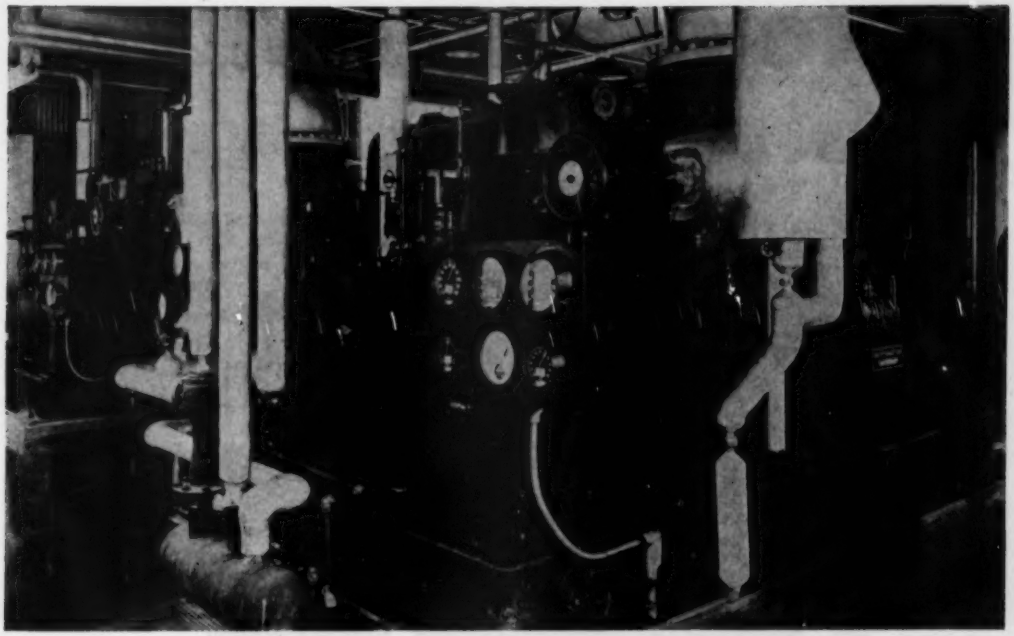

Three Jobs for Steam—all powered by Worthington

They get a lot of work out of steam at Burnell-North Pettus Cycling plant near Pettus, Texas, operated by Stanolind Oil and Gas Company.

The Worthington turbine generator shown above is one of two providing electric power for general plant service. The steam turbines are 1,500 kw units, operating at 600 lb. gauge, 725 Ftt, and exhausting to 27 in. vacuum. The generators operate at three phase, 60 cycles, 70% power factor and are equipped with top-mounted air coolers.

There are also *nine* Worthington mechanical-drive turbines at this plant. Seven of these drive centrifugal pumps, and two drive induced-draft fans.

So – three jobs in all: electricity, pumps, fans.

This reliance on Worthington steam turbines is duplicated throughout the petroleum industry. Whether you want turbine-generator sets up to 10,000 kw or mechanical-drive turbines, Worthington has the correct type and size, with the petroleum industry's stamp of approval. A broad line of power plant equipment, giving you *unit responsibility*, and our unmatched experience in power plant applications are further reasons for doing business with Worthington.

Get the *savings* that steam offers—get *more work* out of steam. *There's more worth in Worthington.* For bulletins, write Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N.Y.

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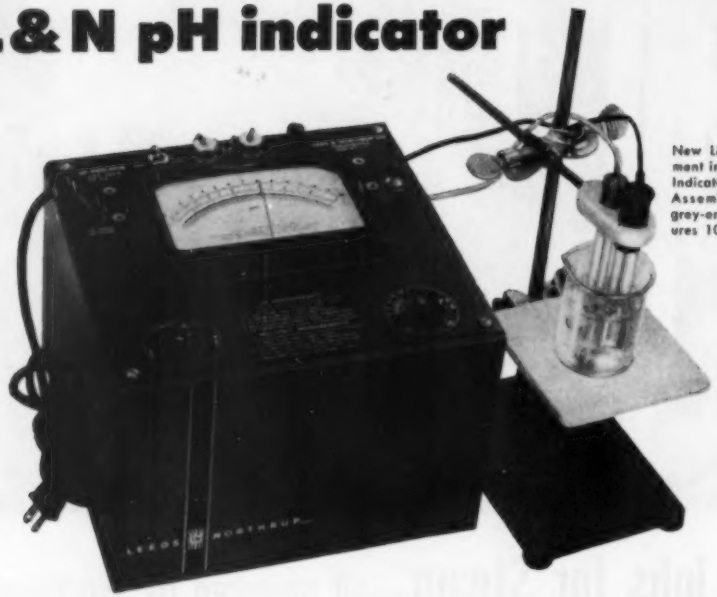
T.1.2

A GREAT TEAM IN STEAM

ANNOUNCING *a new stabilized*

L&N pH indicator



New L&N pH Indicator. Equipment includes: line-operated pH Indicator and Electrode Holder Assembly. Indicator case, of grey-enameled aluminum, measures 10½" x 10¼" x 8⅜".

- **eliminates range changing**
- **readable to within ±0.02 pH**

This *converter-type* pH Indicator offers remarkable stability. Embodying important refinements in circuit design, it is unaffected by normal fluctuations in line voltage . . . or by zero drift of the amplifier.

In lab or plant—you'll appreciate the many advantages of this new instrument. The few required adjustments are simple to make. Single, *continuous* pH 0 to 14 scale eliminates range changing . . . a big help when you're working near pH 7. And you can read to within ±0.02 pH . . . on either grounded or ungrounded solutions.

Key to stability: the Indicator incorporates the high quality shielded *converter* developed for our Speedomax electronic recorders. Its circuit employs d.c. to a.c. conversion, a.c. amplification, and conversion back to d.c. for voltage feedback. Conversion stabilizes zero. Feedback stabilizes gain.

For details—send for Folder EM9-96(1). Write 4923 Stenton Ave., Phila. 44, Pa.

Check these distinctive L&N advantages...

- ✓ **Continuous 5½" scale**—covers full range of pH 0 to 14 . . . readable to ±0.02 pH.
- ✓ **Electrode system**—takes any suitable type . . . but circuit especially designed for high resistance glass electrode systems.
- ✓ **Grounded or ungrounded solutions**—can be checked with equal ease and accuracy.
- ✓ **Only 2 controls, 1 switch**—standardization and temperature-millivolt controls . . . zero switch.
- ✓ **4 voltage ranges**—0 to +700, 0 to −700, 0 to +1400, and 0 to −1400 mv . . . for redox work and Karl Fischer Titration measurements.
- ✓ **Fast warmup**—not more than 1 minute.
- ✓ **Short response time**—1.5 seconds . . . for most readings.

LEEDS NORTHRUP

Jrl Ad EM9-96(1)

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A Revolutionary Metallurgical Development

DUCTILE IRON is a cast ferrous product which combines the *process advantages* of cast iron with many of the *product advantages* of cast steel.

No longer in the pilot-plant stage, this new material is now produced and sold on the basis of specifications. Not only are its individual properties exceptional, but no other common engineering material provides such a combination of excellent castability and fluidity, with high strength, toughness, wear resistance, and machinability.

Actually, "ductile iron" denotes not a *single* product, but rather a family of ferrous materials characterized by graphite in the form of spheroids . . . a form controlled, in a broad sense, by small amounts of magnesium. Presence of spheroidal rather than flake graphite gives this new product a ductility that is unique among gray cast irons.

Four important types of ductile iron now being produced commercially are tabulated below.

REPRESENTATIVE MECHANICAL PROPERTIES OF COMMERCIAL HEATS OF DUCTILE IRON

	Grade	Tensile strength, psi	Yield strength, psi	Elongation per cent	BHN	Usual condition
A	90-65-02	95/105000	70/75000	2.5/3.5	225/265	As-cast
B	80-60-05	85/95000	65/70000	5.5/10.0	195/225	As-cast*
C	60-45-15	65/75000	50/60000	17.0/23.0	140/180	Annealed
D	80-60-00	85/95000	65/75000	1.0/3.0	230/290	As-cast

A Pearlitic in structure. Provides good mechanical wear resistance.

B Pearlitic-ferritic in structure. Provides strength and toughness combined.

C A fully ferritic structure usually obtained by short anneal of either (A) or (B). Provides optimum machinability and maximum toughness.

D Higher phosphorous content than preceding grades, also higher manganese. Provides high strength and stiffness, but only moderate impact strength.

SOME UNIQUE PROPERTIES OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness . . .

2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core. No other single material can combine these properties . . . its only counterpart being a tough material coated with a hard welded overlay.

3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.

4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.

5. It can be satisfactorily welded.

APPLICATIONS

Automotive, agricultural implement, railroad and allied industries apply ductile iron, as-cast and heat treated, in components too numerous to detail.

Machinery, machine tools, crankshafts, pumps, compressors, valves and heavy industrial equipment such as rolls and rolling mill housings, utilize its high strength and rigidity.

In scores of engine, furnace and other parts serving at elevated temperatures, it provides oxidation and growth resistance heretofore unavailable in high carbon castings.

Other applications include paper, textile and electrical machinery, marine equipment, and pipe.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron . . . mail the coupon now.

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SCRAPED SURFACE *Exchangers*

IF you are all "gummed up" with a tough heat transfer problem, Vogt Scraped Surface Exchangers will provide the answer. They have patented scraper elements which prevent fouling of the heat transfer surfaces and insure the highest rate of heat exchange between the product and the cooling or heating medium. The scrapers also continuously agitate the fluid and assist removal of solids from the unit.

DOUBLE PIPE EQUIPMENT is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

SHELL AND PIPE TYPE UNITS are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

Write for Bulletin PE-1

*DOUBLE PIPE UNIT. Drive and close-up of 12 section unit under test in our shop.

*SHELL and PIPE UNITS. Two of five units installed in a leading petroleum refinery.

*Patented

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It's better
to be right
the first time
POWELL

CORROSION

CHEMICAL RESISTANCE OF "KARBATE" PRODUCTS

This table shows the grade of "Karbate" Impervious Graphite and the type of "National" Resin Base Cement recommended for commercial use in the more common corrosive chemicals. The concentrations and temperatures listed are based on field and laboratory experience, but *the satisfactory use of these materials is not limited to the chemical reagents or conditions shown in this table.*

Chemical Reagent	Concentration	Fluid Temperatures up to	Recommendation	
			Grade	Cement
ACIDS				
Acetic acid	All	Boiling	22	14
Acetic anhydride	100%	Boiling	22	14
Arsenic acid	All	Boiling	22	14
Boric acid	All	Boiling	22	14
Carbonic acid	All	200° F	22	14
Chromium trioxide, aq. soln.	0-10%	Boiling	22	14
Citric acid	All	Boiling	22	14
Formic acid	All	Boiling	22	14
Hydrobromic acid	All	Boiling	22	14
Hydrochloric acid	All	Boiling	22	14
Hydrofluoric acid	All	195° F	x	14
Hydrofluoric acid	41-60%	—	22	14
Hydrofluoric acid	Over 60%	Boiling	22	14
Hydrofluoric acid	All	Boiling	22	(†)
Hydrofluoric acid	All	212° F	22	(†)
Hydrogen sulphide-water	100%	185° F	22	
Lactic acid	0-10%	140° F	x	14
Monochloroacetic acid	10-20%	—	22	14
Nitric acid	Over 20%	Boiling	22	14
Nitric acid	100%	Boiling	22	14
Nitric acid	All	Boiling	21	14
Oleic acid	0-85%	Boiling	22	(†)
Oxalic acid	100%	Boiling	22	
Phosphoric acid	0-75%	338° F	x	14
Stearic acid	75-96%	—	22	14
Sulfuric acid	Over 96%	Boom	22	
Sulfuric acid	All	Boiling		
Sulfurous acid	All			
Tartaric acid				
ALKALIES				
Ammonium hydroxide	All	Boiling	22	15
Monoethanolamine	All	Boiling	22	15
Sodium hydroxide	0-62%	Boiling	21	15
Sodium hydroxide	62-80%	275° F	21	15
Tetramine C	All	Boiling		
SALT SOLUTIONS				
Aluminum Chloride	All †	Boiling	22	14
Ammonium thiocyanate	0-63%	Boiling	22	14
Arsenic trichloride	100%	230° F	22	x
Calcium chlorate	0-10%	140° F	22	14
Calcium hypochlorite	All	90 °F	22	14
Cupric chloride	All	Boiling	22	14
Ferric chloride	All	Boiling	22	14
Ferrous chloride	All	Boiling	22	14
Ferrous sulphate	All	Boiling	22	14
Manganous sulphate	All	Boiling	22	14
Nickel chloride	All	Boiling	22	14
Nickel sulphate	100%	Boiling	22	14
Phosphorus trichloride	All	Boom	21	14
Sodium chloride	0-4%	Boiling	22	14
Sodium chlorite	0-25%	Boiling	22	14
Sodium hypochlorite	All	Boiling	22	14
Stannic chloride	All	Boiling	22	
Zinc ammonium chloride	All			
Zinc chloride	All	338° F	22	14
Zinc sulfate			x	
HALOGENS, AIR, WATER			22	14
Air	—	Boom	22	14
Bromine	100%	Boom	22	14
Bromine water	All	Boom	x	
Chlorine—dry	100%	Boiling	x	
Chlorine water	100%			
Iodine				
Fluorine				

Chemical Reagent	Concentration	Fluid Temperatures up to	Recommendation	
			Grade	Cement
HALOGENS, AIR, WATER (cont.)				
Steam	—	338° F	22	14
Water	—	Boiling	22	14
ORGANIC COMPOUNDS				
Acetone	0-100%	Boiling	22	14
Amyl alcohol	100%	Boiling	22	14
Aniline	100%	338° F	22	14
Aniline hydrochloride	100%	Boiling	22	14
Benzene	100%	212° F	22	14
Benzene hexachloride	100%	Boiling	22	14
Butyl alcohol	0-100%	Boiling	22	14
Butyl "Cellosolve"*	100%	Boiling	21	14
Butyl "Cellosolve"*	0-100%	252° F	22	14
Carbon tetrachloride	100%	Boiling	22	14
"Cellosolve"*	100%	140° F	22	14
Chlorethylbenzene	—	338° F	22	14
Chloroform	100%	Boiling	22	14
Dioxidine	0-100%	Boiling	22	14
Dowtherm	0-100%	122° F	22	14
Dioxan	0-8%	200° F	22	14
Ethyl alcohol	100%	Boiling	22	14
Ethylene chlorhydrin	100%	Boiling	22	14
Ethylene dibromide	Saturated	Boom	22	14
Ethylene dichloride	100%	Boiling	22	14
Ethyl mercaptan—water	100%	338° F	22	14
Freon 11 and 12	0-100%	Boiling	22	14
Gasoline	100%	Boiling	22	14
Glycerine	0-100%	Boiling	22	14
Isopropyl acetate	100%	Boiling	22	14
Isopropyl alcohol	100%	Boiling	22	14
Isopropyl ether	All	Boiling	22	14
Kerosene	100%	Boiling	22	14
Mannitol	0-100%	Boiling	22	15
Methyl isobutyl ketone	100%	Boiling	22	14
Methyl alcohol	100%	Boiling	22	14
Monochlor benzene	100%	Boiling	22	14
Octyl alcohol	100%	Boiling	22	14
Paradichlorbenzene	100%	Boiling		
Paraldehyde	100%			
Tetrachlorethane, sym.		Boom	22	14
Trichlorethylene	25%	140° F	22	14
MIXTURES	20%		22	15
Ammonium persulfate plus sulfuric acid	30%	Boiling	x	
Calcium chloride plus calcium chlorate	10%		22	14
Chlorinated ethyl alcohols	All	Boiling	22	14
Chrome plating solns.	All			
Hydrochloric acid sat. with chlorine	Over 20%	Boiling	22	14
Nickel plating solns. (chloride)	All	Boiling	22	14
Nickel plating solns. (sulfate)	All	140° F	22	(†)
Nitric acid plus hydrofluoric acid	15%			
Oakite acid materials—O.C. 32, O.C. 33, O.C. 84A, O.C. 84M, CRYS.	5%			
O.C. 87, O.C. 88	All	Boiling	22	14
Perkorizing solution	All	Boiling	22	14
Rayon Spin bath	All	Boiling	21	14
Sodium hypochlorite plus sodium hydroxide	0-25%	Boiling	x	—
Sulfuric acid plus citric acid	96%			
	33%			

(x) Not recommended

NOTE: (†) "National" No. 14 Cement used with threaded joints will give serviceable life.
(*) The term "Cellosolve" is a registered trade-mark of Union Carbide and Carbon Corporation.

The terms "National" and "Karbate" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

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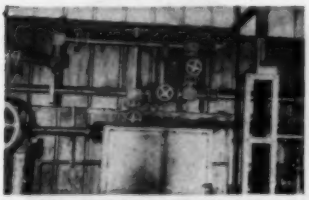
...AND THE CONSERVATION OF CRITICAL MATERIALS

INSTALL NATIONAL TRADE-MARK carbon and graphite and "Karbate" impervious graphite equipment for processing, conveying and storage of corrosive fluids.

IMMUNE TO THERMAL SHOCK • LIGHT WEIGHT • NO METALLIC CONTAMINATION • LONG LIFE—LOW MAINTENANCE

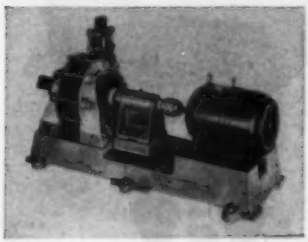
HEAT EXCHANGERS

Wide variety of standard and custom built models in time-proven designs. Shell and tube, cascade, concentric and immersion types available in stock sizes. High rates of heat transfer. Catalog Sections S-6620, S-6690, S-6715, S-6716, S-6750, S-6780.



PIPE, FITTINGS AND VALVES

Complete standard line to handle your toughest fluid conveying requirements. Easy to install and maintain with simple hand tools. Catalog Section S-7000.



PUMPS

The centrifugal pump for handling corrosive fluids—rugged design, simple construction, trouble-free rotary seal. Handling capacities to 800 G. P. M. Catalog Section S-7200.

TOWERS

"Karbate" impervious graphite towers for absorption, fractionation, extrusion, scrubbing and many other processing operations. Easily erected from standardized monolythic sections and components. Catalog Section S-7350.

BRICK

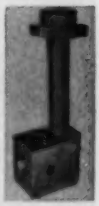
Accepted material for lining tanks, towers, digesters and other vessels containing corrosive chemicals. Catalog Section S-6210.

HCL COMBUSTION CHAMBERS

Versatile, standardized line for hydrogen chloride synthesis. Burns moist gas. Simplicity of operation. Catalog Section S-7530.

STEAM JETS

Withstand severe corrosive conditions and thermal shock in heating and agitating corrosive solutions by direct injection of steam. Catalog Section S-7300.



GROUND ANODES

"National" Graphite Ground Anodes for cathodic protection of buried, submerged or exposed metallic structures provide for control of current input to meet specific environmental conditions. Catalog Section S-6510.

HCL ABSORBERS

Standard and custom built models to meet *any* hydrochloric acid production requirement. Falling-film principal of absorption — proven efficient and compact design. More HCL produced in "Karbate" absorbers than in all other types combined. Catalog Section S-7430.

They're DROP FORGED

of STEEL...

W-S Screw-End and Socket-Weld Fittings

There are several big benefits to you implied in this simple statement of fact about W-S Fittings.

First, forging means *strength*—the strongest, most compact physical form, steel for steel, obtainable by commercial methods of fabrication.

Second, *being* stronger, forged fittings are much *smaller* and *lighter*, size for size, than other types.

Third, *dimensional accuracy* is characteristic of the forging process—and because forged bodies *are* more accurate, they chuck better, can be machined to *closer*, more *uniform tolerances* than other types.

To these inherent advantages of *forged* fittings, add Watson-Stillman's modern manufacturing facilities, a production control system that's air-tight from furnace to finished product, and a sales engineering staff dedicated to SERVICE in the largest sense of the word. The total is heavily weighted in favor of the advantages of W-S Double-Diamond Forged Steel Fittings.

• Lower Service Cost • More Uniform
• Stronger • Smaller • Lighter • Tighter

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ESTABLISHED 1848

W-S

9-M-1

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ROSELLE, NEW JERSEY

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designs

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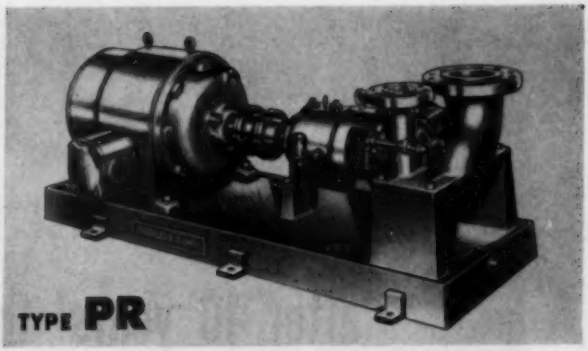
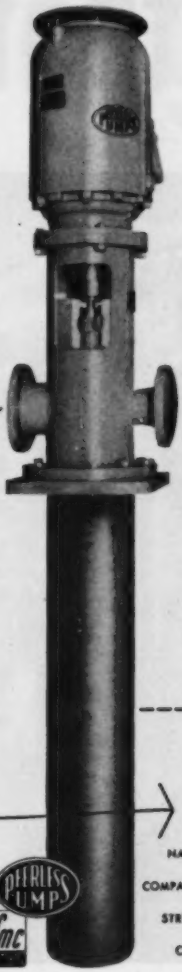


TYPE **PR**

PEERLESS PUMP

like **THE PEERLESS HYDRO-LINE** **A HIGH PRESSURE, MEDIUM CAPACITY, BOOSTING AND CIRCULATING PUMP.** Packing gland or mechanical shaft seal construction available. Especially suited to condensate return service and for handling hydrocarbons, hot or cold water and mild salt solutions at temperatures from 0°F to 400°F. This encased, close-coupled, vertical, turbine pump is ideal for limited NPSH application in field and refinery service and for installations where space is at a premium. Its construction flexibility ideally suits it to future as well as present system needs. Easiest to install, operate and maintain. Use coupon below for Bulletin No. B-592 which describes construction details and operating characteristics.



like **THE PEERLESS TYPE PR**

A HIGH TEMPERATURE, HIGH PRESSURE PROCESS PUMP. Packing gland or mechanical shaft seal construction available for handling hydrocarbons, water and chemical solutions at high temperatures and pressures. Designed with more than a score of engineered features that add up to real process pump superiority. Here are a few advantages: maximum parts interchangeability, extra low NPSH requirements, availability in various alloys, end or top suction design, complete range of sizes. Use the coupon below for Bulletin No. B-1605 which describes construction details and operating characteristics.

SELECT YOUR PUMP FROM THE COMPLETE PEERLESS LINE

A pump for every purpose is more than a Peerless slogan, it's a Peerless fact. Whether your requirements call for a vertical pump or a horizontal pump, Peerless can furnish the pump to meet your specifications from its complete line. You can choose from scores of Peerless types, hundreds of Peerless models for thousands of pumping applications. Peerless service is nationwide. Call the office nearest you for a Peerless field engineer. He can help you buy and apply the right pump from Peerless' comprehensive and complete line.

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PEERLESS PUMP

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☐ HYDRO-LINE PUMP ☐ TYPE PR PUMP

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COMPANY_____

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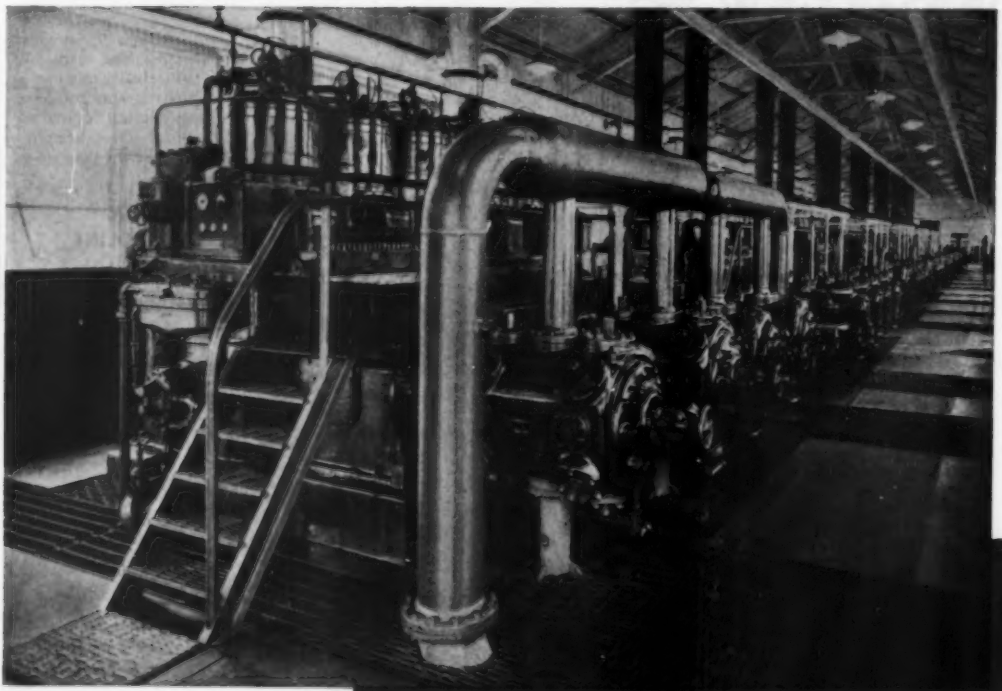
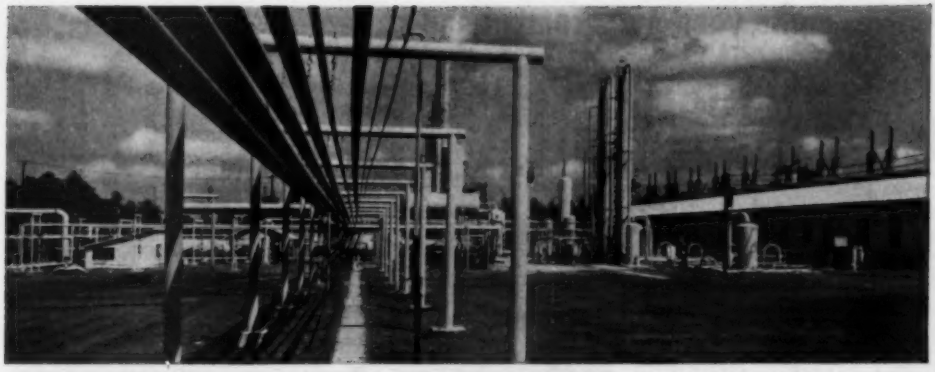
PR

a mere .013″ of power cylinder wear after 10 years' full-load operation

...that's Clark



Eight Clark RA-6, 600 bhp Right Angle Compressors in Smackover, Arkansas, natural gasoline plant of Lion Oil Company



Compressor station (right) at Lion Oil Company's natural gasoline plant, Shuler, Arkansas

quality for you!

Clark "Right Angle" Compressors set remarkable record in Lion Oil Company operated Shuler Unit Natural Gasoline and Pressure Maintenance Plant

Power cylinder wear of less than .00125" per year after initial break-in! Total average wear of .013" per cylinder for the whole 10-year period!

. . . that's the remarkable record of six Clark RA-6, 600 bhp Right Angle, Gas-Engine-Driven Compressors operating continuously at full load since 1941 in Shuler Unit, Arkansas natural gasoline and pressure maintenance plant which is operated by Lion Oil Company.

But that's not all that's remarkable about this installation. The original power piston rings were in service for 8½ of those years before needing replacement.

Two other Clark RA-6 units operating since 1943 and 1948 respectively, are showing the same unusual resistance to wear . . . the same extremely low maintenance.

That's Clark quality and durability for you!

There's a BIG difference in . . . **CLARK®**

COMPRESSORS

CLARK BROS. CO., INC. • *One of the Dresser Industries* • OLEAN, N. Y.

make your own comparison...

a Fluor-GR Fin-Fan

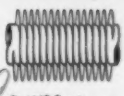
against any other air-cooled heat exchanger

When considering air-cooled heat exchanger equipment, compare the advantages of a Fluor-GR Fin-Fan. Make comparisons of structural simplicity and flexibility. Compare the exclusive features of the Griscom-Russell K-Fin section, the rugged yet precision design of Fluor mechanical equipment. Check *proven performance* in such varied services as gas transmission systems, petroleum refineries, light hydrocarbon processing plants, chemical processing plants, and power and industrial plants. Before you buy or specify, compare the Fluor-GR Fin-Fan. A Fin-Fan provides more exclusive design features —features that add up to *efficient, dependable* performance—than any other make of air-cooled heat exchanger. Write for Fluor Bulletin No. FF-8501.

Compare

structural design

Structurally, the Fin-Fan is the ultimate in simplicity and flexibility. Its "truss-type" design provides a rugged, vibrationless unit, free of extraneous parts. Uniform prefabrication of parts, with bolt holes and orientation incorporated in basic design, permits easy extension without shut-down of existing units!



Compare

K-Fin features

G-R K-Fins are tension-wound for moderate temperatures, rolled into grooves for elevated temperatures. Threaded header plugs provide quick, easy access to tube ends for cleaning or replacement. Plugs are shoulder-tight to form a leakproof metal-to-metal joint at all pressures, independent of thread tightness.

Compare

mechanical equipment

Fluor mechanical equipment is ruggedly designed to meet specific heat transfer requirements. 4 basic gear units cover 4 different and distinct horsepower ranges. This, coupled with a choice of fan assemblies ranging from 8'-6" to 20' in diameter, with 4 or 6 blades per fan unit, enables the proper combination of gears and fans to effect optimum efficiency.

Compare

proven performance

More Fluor-GR Fin-Fan Air-Cooled Heat Exchangers are in service throughout the continental United States and in countries abroad than any other make. More Fluor-GR Fin-Fan installations are the result of repeat orders than any other type. Check with your nearest Fluor Representative for the Fin-Fan's outstanding record of proven performance—in services and duties similar to your own!

FLUOR

Engineers - Constructors - Manufacturers

THE FLUOR CORPORATION, LTD., 2500 S. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
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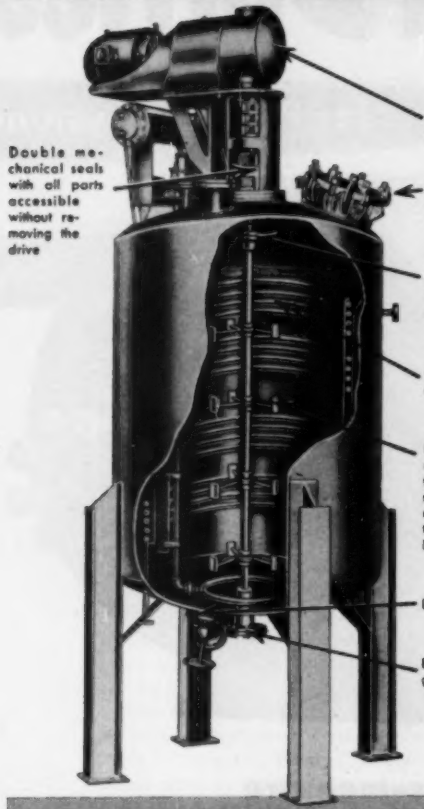
NOW!

The Struthers Wells Hydrogenator

featuring

Advanced Agitator Design for Quick and Thorough Dispersion of Gases and Solids


Double mechanical seals with all parts accessible without removing the drive
Standard make right angle motoreducer
Manhole with hinged cover
Semi-flexible coupling protects drive equipment and pressure seals
Cooling and heating coils
Removable arm radial propeller agitator, giving excellent shearing action and rapid overturning of the liquor, self cleaning in operation
Bottom flush valve
Removable bottom guide bearing

The agitators, supporting structure, agitator shaft seals and drive incorporated in the new Struthers Wells Hydrogenator have been carefully designed to give maximum efficiency and long trouble-free service in dispersing gases and catalysts under normal or extreme conditions of temperature and pressure.

The diagrammatic illustration at the left shows how the agitator shaft is independently supported at two points within the vessel. Note how the radial propeller agitators are mounted in multiple on the shaft dividing the overturning of the content into several strata. The coils are carefully located to provide minimum obstruction to proper agitation and the flush outlet valve eliminates a pocket into which the catalyst might accumulate. This type of equipment is ordinarily made of stainless, nickel, monel, inconel or mild steel and individually designed to operate under specific conditions of pressure, vacuum, temperature and degree of agitation.

RADIAL PROPELLER AGITATOR

Because of its high peripheral blade speed and the rapid overturning and turbulent motion it imparts to the liquor, the radial propeller effectively disperses and entrains both the hydrogen and catalyst within the liquors to be treated thereby creating the optimum condition necessary to a maximum absorption and reaction. The removable arm feature provides inexpensive adjustment of the degree and type of agitation which might be necessary due to change of process or operating conditions.

Write for Complete Data

Struthers Wells

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Process Equipment Division ... Warren, Pa.

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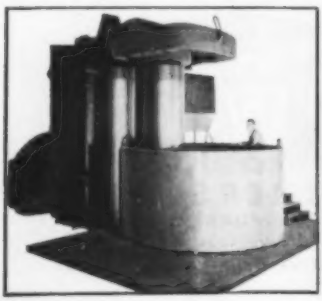
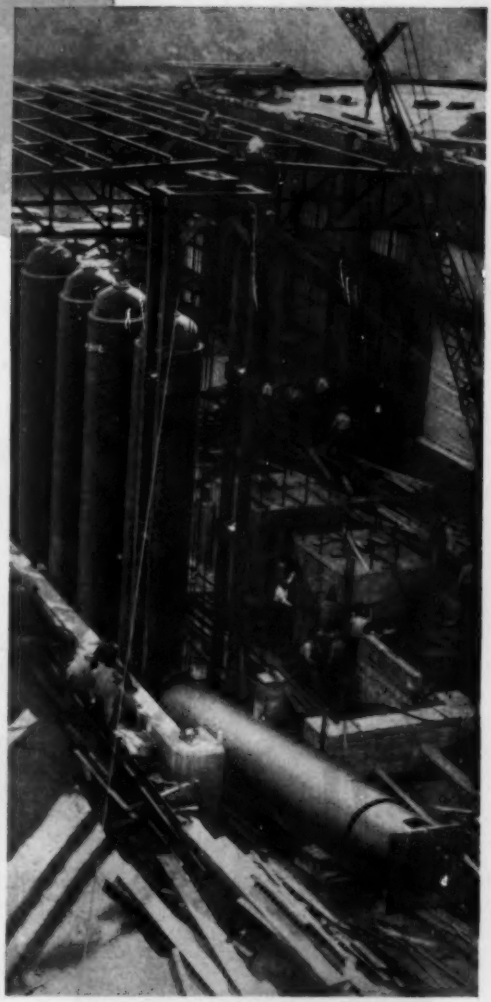
. . . for Pressure Systems

made-to-measure

built-to-last



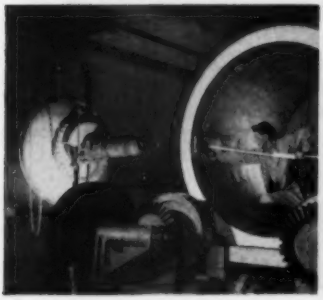
Up to 6000 psi

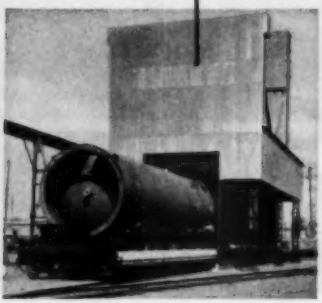


Installation of B&W Accumulators, for use in connection with hydraulic presses.

For pressures from 2000 to 6000 psi, B&W Banded Pressure Vessels have the advantage of withstanding higher pressures than vessels made by conventional welding construction. The inner vessel, fabricated in accordance with the ASME Code, withstands longitudinal pressure loading. A series of circumferential bands reinforces the inner shell, and enables it to withstand circumferential loading.

Uncompromising care and advanced techniques go into every B&W manufacturing step to assure the ultimate in safe and sound process equipment. Forming, machining, welding, stress-relieving—every production operation from start to finish of B&W pressure vessels—is performed on equipment specifically designed for each purpose. Much of the equipment and types of construction are original B&W developments.

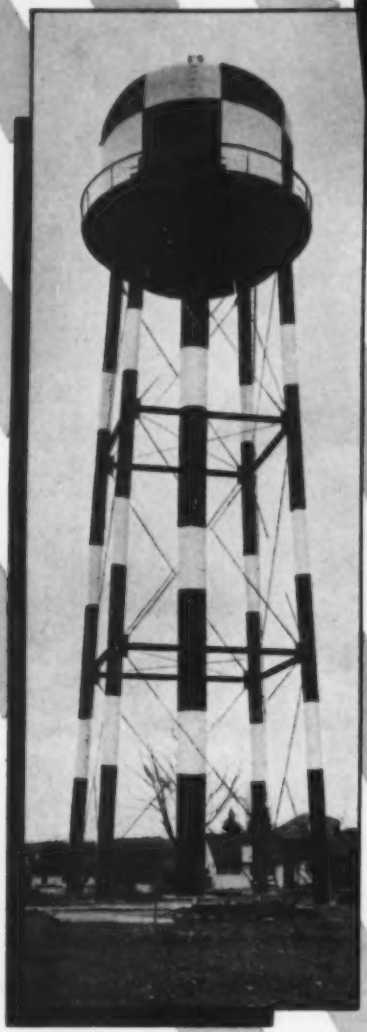




BABCOCK & WILCOX

S-402 F

Here's a Steel Plate Fabricator Who Talks The OIL MAN'S LANGUAGE



For a long time . . . and on a wide range of steel plate construction and erection jobs . . . Posey Iron has been "talking it over" with oil men. Practical, work-a-day experience with refinery and oil field installations has acquainted Posey Iron engineers with "the facts of life" in the oil business.

You'll find we understand peak loads . . . pressures . . . reserve capacities . . . fire protection requirements . . . alloys . . . welding practice . . . and specialized construction *as they apply to the oil field.* Every Posey Iron tank is fabricated with an ample safety factor . . . and to meet standard codes.

The Posey Iron Work's plant (16½ acres under roof) has complete facilities for machining . . . x-raying . . . pickling and painting. A consultation with one of our engineers may result in economies in your steel plate fabrication work.

View of 200,000 gallon tank with ellipsoidal bottom designed, fabricated and erected by the Posey Iron Works

Alloy Steel Refinery Pipe awaiting shipment from Posey Iron's North Plant

Fractionating Column for high octane aviation gasoline 5'11"D. x 133' high

POSEY IRON WORKS, INC.

Steel Plate Division

LANCASTER, PENNA.

New York Office: Graybar Building

ESTABLISHED SINCE 1910

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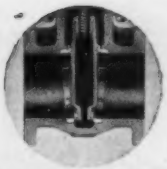
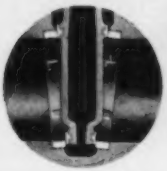
Bolt Machinery
Forgings
Industrial Heating
Iron Castings
Malleable Iron
Steel Plate

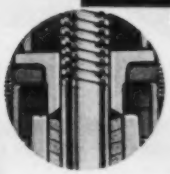


Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.

Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.



Brass Liner on Glands assures greater resistance to corrosion and scoring.

WALWORTH

iron body gate valves

with screwed or flanged ends

... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.

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valves and fittings

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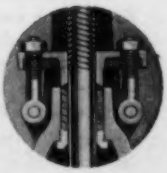
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.

Bronze Back-Seat Bushings in bonnets of OS&Y valves.

Solid Web Type Disc in OS&Y valves for greater strength and longer service.



...as much as 65% to 80%
BY
CHAPMAN

Tilting Disc CHECK VALVES

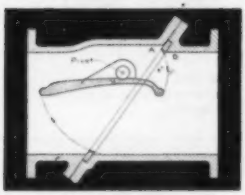
Typical test on a 22-inch Chapman Tilting Disc Check Valve under 450 pounds gas pressure . . . carrying 3,200,000 feet of gas per hour . . . showed a drop in pressure of less than 7 inches of water.

The average reduction of head loss . . . as against conventional check valves . . . is 65% to 80%.

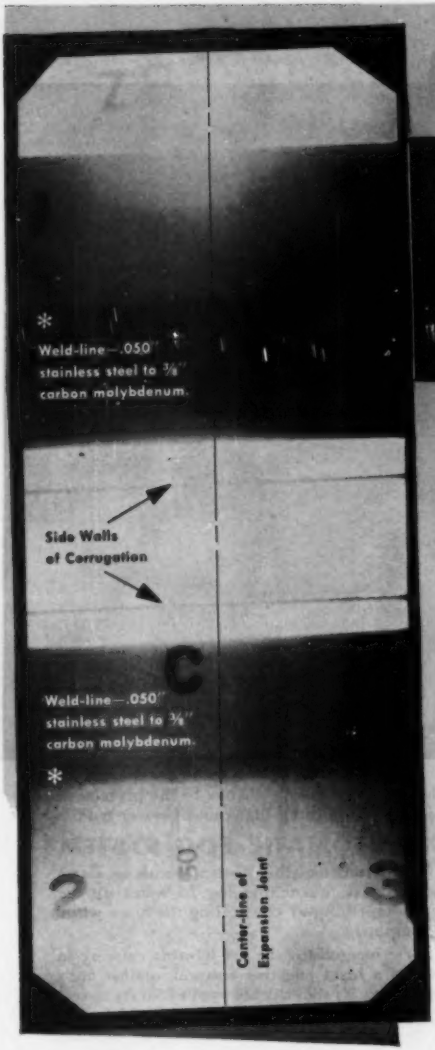
That's because the balanced hinge-pinned disc, of special aerofoil design, has exceptional lifting qualities, lightness in unbalanced weight, and minimum resistance to flow in open position. And valve body is streamlined, with through-way always equal to the area of the pipe.

This means that *disc won't slam* under usual piping arrangements ...and that it seats drop-tight. It means, too, that many new lines can be designed in smaller size. Send for Catalog No. 30, giving complete data and test-curves on Chapman Tilting Disc Check Valves.

THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASSACHUSETTS



Cross-section of the Chapman Tilting-Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.


Weld-line—.050" stainless steel to ⅜" carbon molybdenum.
Side Walls of Corrugation
Weld-line—.050" stainless steel to ⅜" carbon molybdenum.
Center-line of Expansion Joint

HERE'S WHY...

you can't buy a better Expansion Joint than a ZALLEA!

When the U. S. Navy specified use of 180 Zallea Welding Type 347 Stainless Steel Expansion Joints for a steam pipe installation on a new type vessel, job requirements included X-ray examination of all joint-to-pipe welds (.050" stainless steel to ⅜" carbon molybdenum seamless pipe).

This was a rigid test, since the revealing eye of the X-ray would immediately ferret out the slightest defect or trace of slag inclusion that might cause failures at welds after the pipe line went into service.

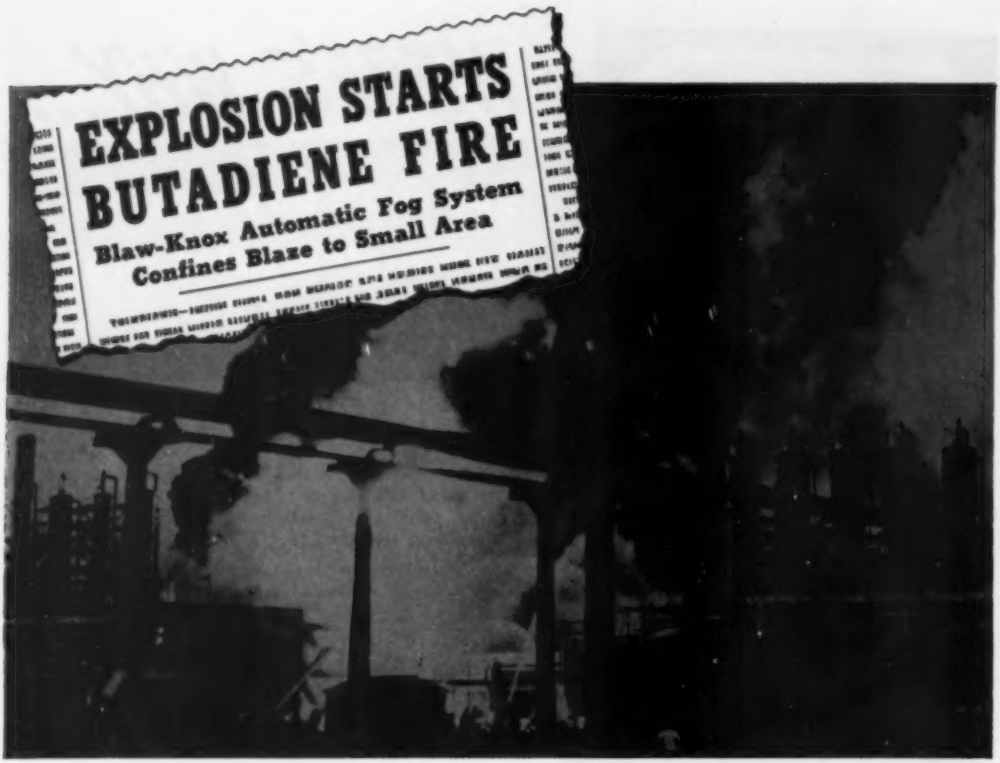
But when X-rayed, *not one* of the 360 Zallea welds disclosed any flaws or slag inclusion! In reporting test results, the independent industrial laboratory making the examination wrote: "*We have never seen more perfect welds under X-ray.*"

The exclusive Zallea *controlled* welding technique used on this job is the same technique applied in the manufacture of every Zallea Expansion Joint that leaves our plant. It's your assurance that when you buy Zallea Expansion Joints, you buy the best. They're better built . . . last *far* longer. So next time you consider expansion joints, specify Zallea . . . you'll find it pays!

Zallea Expansion Joints are available in diameters from 3 inches to 30 feet for temperatures from sub-zero to 1600° F . . . for pressures from vacuum to 300 psi in standard designs and up to 2000 psi in special designs. Zallea Brothers, 890 Locust Street, Wilmington 99, Delaware.

Write today for Catalog 47 and Bulletin 351 which illustrate all Zallea Expansion Joints.

Zallea
EXPANSION JOINTS



A serious fire, yes, but no "total loss"—thanks to the protection of adjacent equipment by smothering blankets of water from a

BLAW-KNOX AUTOMATIC FOG SYSTEM

Actuated by rate-of-rise thermostats, this system sounds an alarm and instantly throws a dense, quenching fog of water on the danger spot—either extinguishing or controlling the blaze while protecting adjacent equipment.

A Blaw-Knox System engineered for the fire hazards existing in or around your plant is a most effective weapon against fire's toll. Your insurance savings as they accrue applied to its cost—provide you with the utmost in fire protection plus a good financial investment . . . Glad to consult with you and submit an estimate without obligation.

Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Foam and Carbon Dioxide Extinguisher Systems.

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Why Phosphorized Admiralty Heat Exchanger Tubes?

Superior Performance in Fresh, Salt or Brackish Waters

In order to assure *uniform chemical composition* and *inherent soundness*, Scovill produces Phosphorized Admiralty tubes by its continuous billet-casting process which consistently maintains the optimum amount of phosphorus. Adding as little as 0.02% Phosphorus to Admiralty also gives maximum resistance to dezincification while retaining all the other desirable properties of this alloy.

Scovill's 40-page Condenser Tube Booklet is available to users who request it on their business letterhead. Scovill Manufacturing Company, 14 Mill Street, Waterbury 20, Connecticut.

Only Scovill Phosphorized Admiralty Has All These Advantages...

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- High resistance to sulfides and other active sulphur compounds
- Satisfactory resistance to weak mineral acids and acid mine waters
- Good resistance to velocities under 7 fps
- Excellent performance at relatively high operating temperatures
- Superior performance in fresh, salt or brackish waters

SCOVILL

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SCOVILL HEAT EXCHANGER TUBES

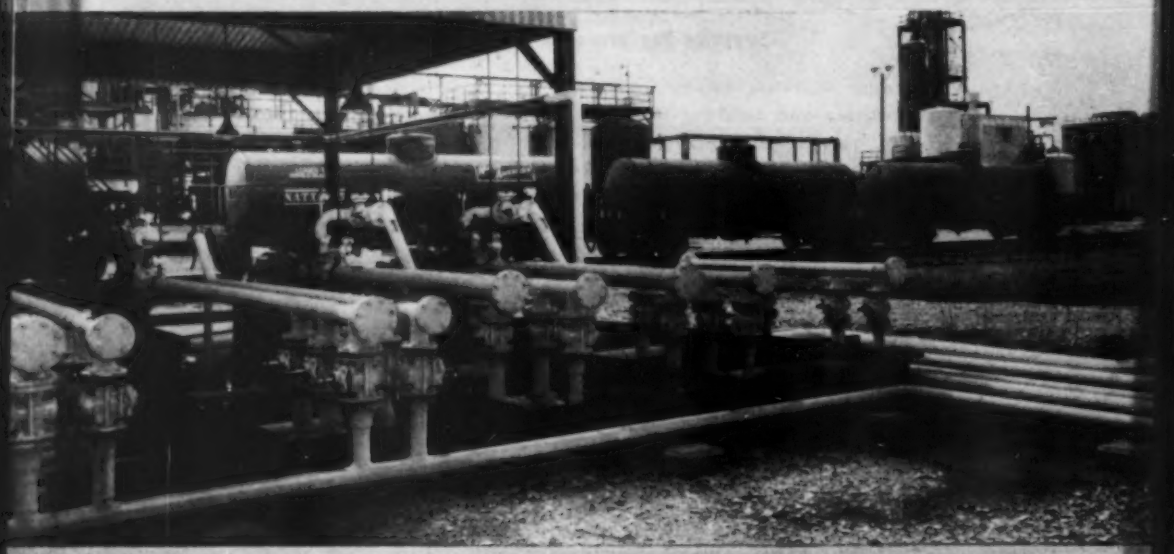
"You can't buy better brass"

There's a Nordstrom Valve for

Examples: RAW MATERIAL, REFINERY GASES,

HOT OIL—Three-way Nordstrom Multiport valves in hot oil service at Wood River, Ill., refinery.

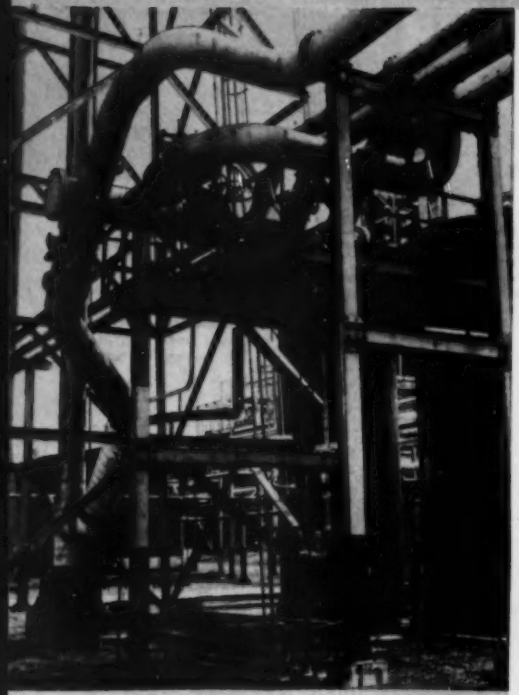
COMPRESSOR LINES—In this giant Louisiana refinery, the compressor lines on gas recovery booster are just one of dozens of different Nordstrom installations.



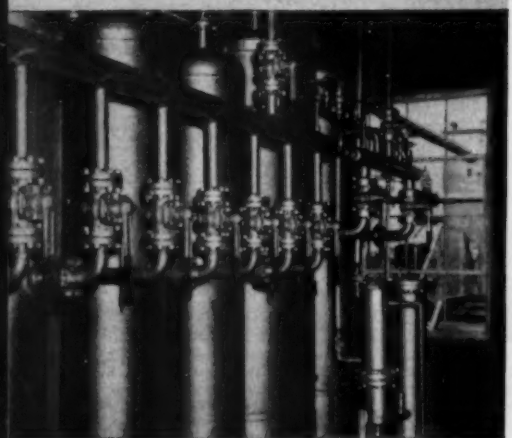
RAW MATERIAL TRANSFER—Manifold in raw material transfer area in this Gulf Coast refinery is completely Nordstrom equipped.

Most Every Refinery Service

HOT OIL, AIR LINES, EQUIPMENT LINES



GAS MANIFOLD—The valves on the manifold to the plant flare, like hundreds of other in this huge New Jersey refinery, are Nordstroms. These particular ones are Fig. 4169.



AIR LINES—Engine air starting tanks in Oklahoma refinery controlled by easy-operating Nordstroms.

No valve is suited to so many refinery services as Nordstrom. Hundreds of thousands of Nordstrom lubricant-sealed valves have been proved in installations wherever petroleum is refined.

For complex, hard-to-hold refinery line fluids there are suitable, cost-saving Nordstrom valves. And because Nordstrom valves fit so many refinery services, storerooms carry smaller valve inventories. Because Nordstroms seldom need repair—because the lubricant-sealed seating ports are never exposed to line fluid—storerooms carry few maintenance parts.

Modern cost-watching refineries have standardized on Nordstrom valves. Let a Nordstrom engineer show you how it pays. Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pa.

Now You Can Easily Fit Nordstrom Valves To Each Service in Your Refining Process

So that refinery engineers can select the proper Nordstrom valves for each service in the principal refining processes, a series of specification sheets showing recommended materials, pressure classes, lubricants and valve figure numbers has been prepared. There is a special Nordstrom Specification Bulletin for each of these processes:

- Catalytic Polymerization
- Crude Topping and Vacuum Distillation
- Cycloversion
- Delayed Coking
- Distillate Recovery in Cycling Plants
- Duo-Sol Solvent Extraction
- Fluid Catalytic Cracking and Gas Recovery
- Girbotol Process
- Houdriflow Catalytic Cracking and Gas Recovery
- Hydroforming Process
- Light Ends Fractionation
- Naphtha Polyforming
- Phenol Extraction
- Propane Deasphalting
- Propane Dewaxing
- Solexol Process
- Solvent Dewaxing
- Thermal Cracking
- Thermal Reforming

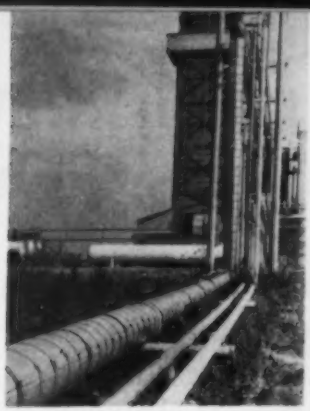
A Nordstrom service engineer will be glad to review these specification sheets with you. Call your nearest Rockwell office or write to Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

Rockwell Another Product **Built**

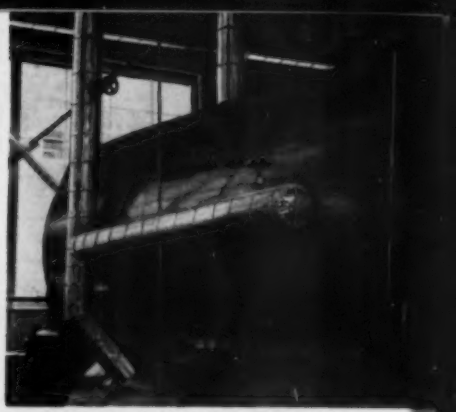
Nordstrom Valves

Lubricant Sealed to Keep Upkeep Down

This big new Oklahoma refinery has used a new kind of aluminum jacketing throughout on both insulated lines and towers and vessels. Light in weight and low in cost, this new Childers Aluminum Jacketing cut installation costs. It is also expected to cut maintenance costs.



Childers Aluminum Jacketing is used here on a cross-country transfer line at a large chemical manufacturing plant in Texas. This is a rugged test for any jacketing, but the light-weight aluminum used in this jacketing should stand up to weather and chemical corrosion it encounters.



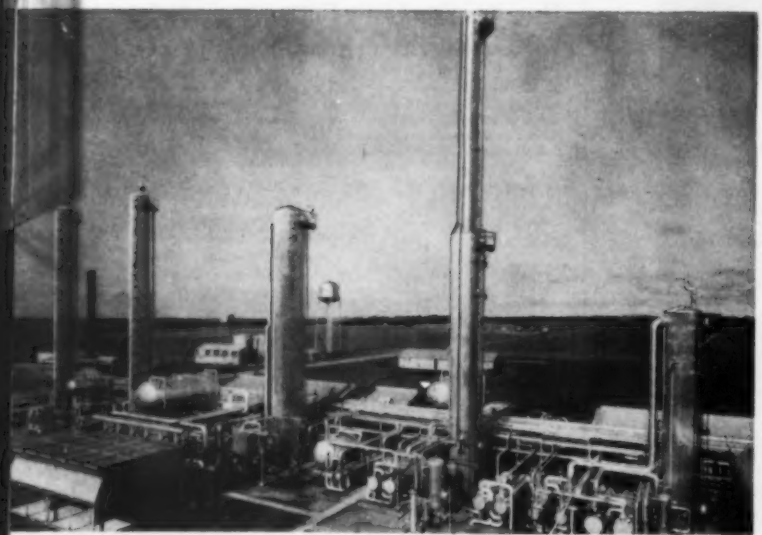
"Good Housekeeping" is the word in this gas pipeline pump station. The insulated lines are handsomely protected by Childers Aluminum Jacketing, which should last as long as the plant itself. The jacketing requires no painting and very little other maintenance. It even allows the interior of the plant to be washed with a hose without harm to the insulation. The chief engineer reports: "We have standardized on Childers Jacketing for all our insulated lines. It is doing an excellent job for us and saving us money."

How 5 plants cut costs of jacketing insulated lines

Weather-resistant, low-cost, easy to put on—these are big reasons for the growing popularity of a new jacketing, specially engineered for insulated lines. It is made of .006" thick aluminum and comes with or without a moisture barrier. It is called Childers Aluminum Weatherproof Jacketing. You can write for a free sample without obligation.

Address Childers Manufacturing Co., Dept. PR-9, 3620 West 11th St., Houston 8, Texas.

Under CMP regulations, Childers is a Class B product, the use of which is not restricted.

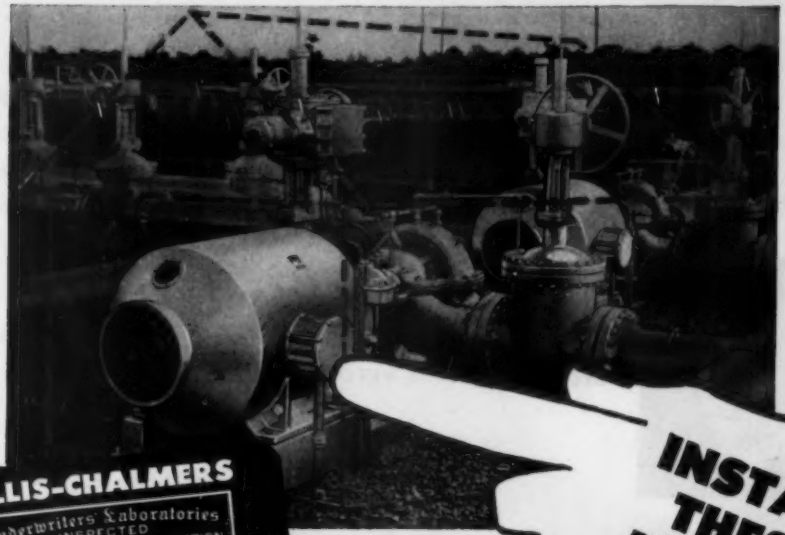


Weather, wind and corrosive gases are not going to attack the insulation of this new plains-country gasoline plant. The insulation is protected by long-lasting aluminum: Childers Aluminum Weatherproof Jacketing. The management expects this low-cost jacketing to hold insulation maintenance costs to a minimum. Other advantages are that the jacketing went on quick and easy during construction; it required no special tools or skill—no shop forming or cutting. It can be taken off and re-used if lines are moved. Aluminum saves on painting and the tough 35 alloy used for Childers Jacketing should stand up for years even in highly corrosive industrial atmospheres. Check the advantages of this jacketing for your own plant.

Amazingly easy to handle, Childers Jacketing was applied here by men using no more than a wooden wedge and a pair of pliers. Childers has engineering representatives in every major industrial center who will be glad to confer with you on your particular jacketing problems. Write to address shown above.

(Advertisement)

No building to buy!



INSTALL THESE MOTORS OUTDOORS

YOU CAN ELIMINATE costly building on many different kinds of installations by using Allis-Chalmers Tube-type, Explosion-proof Motors and installing them outdoors. The motors shown here operate outdoors all year round at a midwestern pipe line booster station. Rain, snow, dirt, the weather's worst conditions, do not affect their dependable operation. And the same kind of savings can be made in hundreds of other applications in the field, on pipe lines and in the refinery.

Self-Cleaning Feature Saves Maintenance

The cooling system in this unique motor is practically self-cleaning. Cooling air is blown through straight, smooth tubes at sufficient velocity to clean out ordinary dirt, even after long shutdowns. There are no corners or pockets to trap dirt or moisture. If sticky dirt clings, a ramrod will clean the tubes in seconds without stopping the motor.

On any type of duty, indoors or out, Allis-Chalmers Tube-type, Explosion-proof Motors reduce maintenance by keeping themselves clean. Get full details from your Allis-Chalmers Authorized Distributor or District Office. Or write Allis-Chalmers, Milwaukee 1, Wis., asking for bulletin 51B7149.

A-3696

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

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TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

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The complete line of American Thermometers and Temperature Measuring Instruments simplifies selection for specific applications. Write for a copy of our new catalog.

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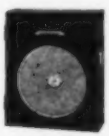

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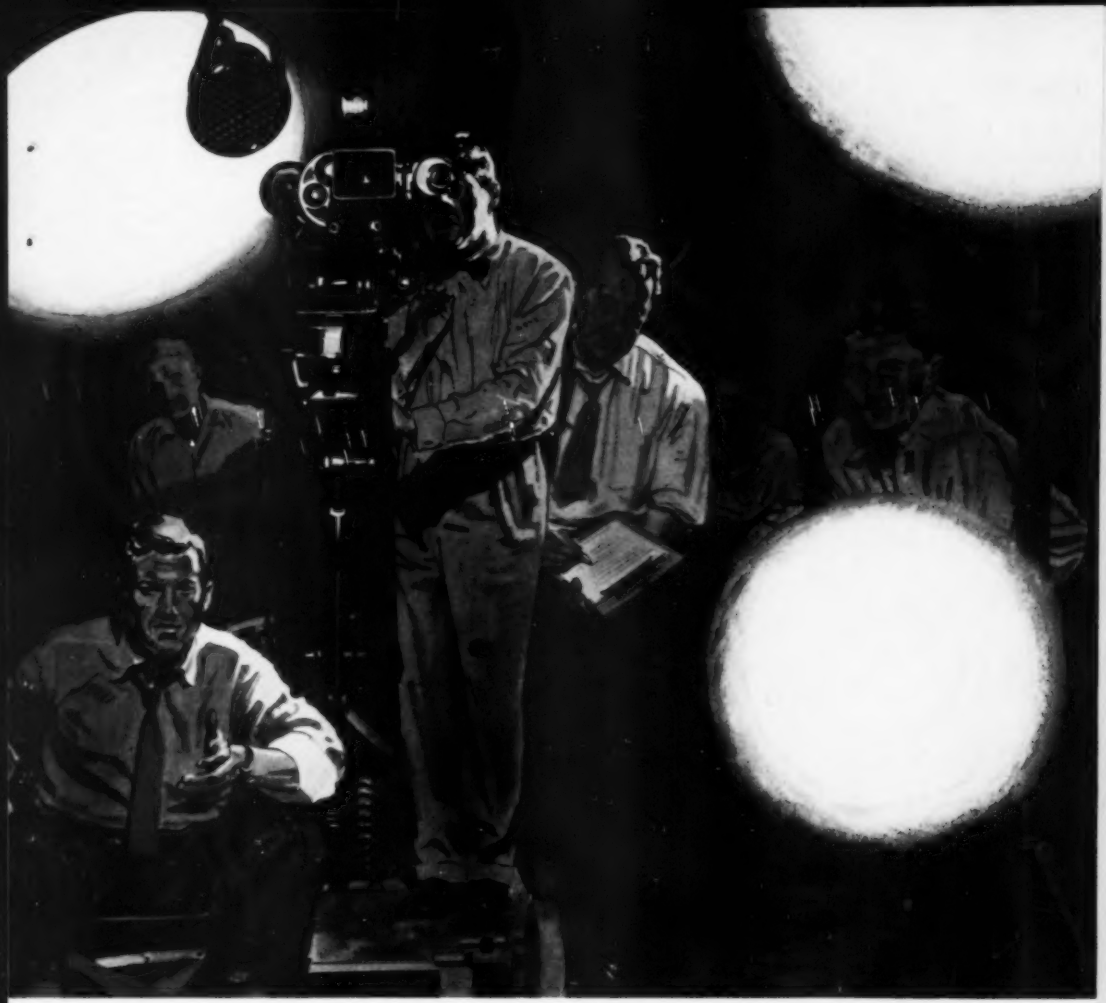

Slightly Colossal

We are under no illusions that the twenty-seven films currently in the Ethyl Motion Picture Library will ever win "Oscars." By Hollywood standards they are only slightly colossal . . . but we believe they have been of tremendous value to our customers over the years.

What our films may lack in glamour, they most certainly make up in educational value. The subjects are ones that are close to the heart of any petroleum man trying to make better products, train his people to handle fuels more safely, or assist his customers to get more from the fuels and lubricants he supplies.

A glance at the following page will give you a good idea of the films we have available . . . and probably suggest uses for them in your own operations.

(*continued on next page*)

Slightly Colossal

(continued from preceding page)

Fire Power—A 24-minute film on the safe handling of gasoline, particularly in service stations and bulk plants.

Fundamentals of Fuel Knock—A highly technical report of fuel combustion studies being conducted at M.I.T. under an Ethyl grant. Running time, 27 minutes.

You're the Doctor—An interesting story about farm equipment service—in particular, a valve job on a tractor engine. 32 minutes.

There Is a Difference—Tells of a new service station operator learning about customer relations. Running time, 22 minutes.

Gasoline for Everybody—A brief but complete story of how gasoline is made and its importance to daily living. Running time, 13 minutes.

Pattern for Progress—A 20-minute color film about the influence of tractor power on agriculture as seen through the eyes of one farm family.

We will be happy to send you a complete catalogue of films in the Ethyl library. If you need a particular film in a hurry, our regional offices maintain a full stock for quick service. Of course, there is no charge for these films. They are a part of Ethyl's service to the oil industry.

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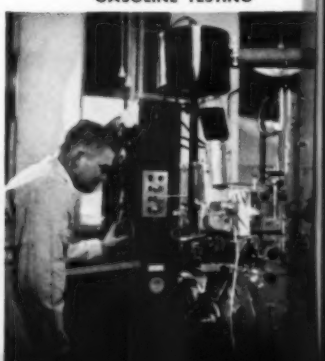

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NATURAL GASOLINE MEN

GREETINGS

from the

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We are looking forward to seeing you at the
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of the
NATURAL GASOLINE ASSOCIATION OF AMERICA
April 30, May 1-2, 1952, Rice Hotel, Houston, Texas

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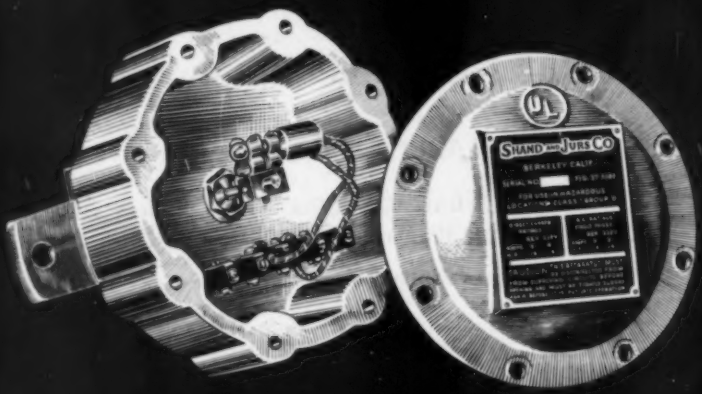

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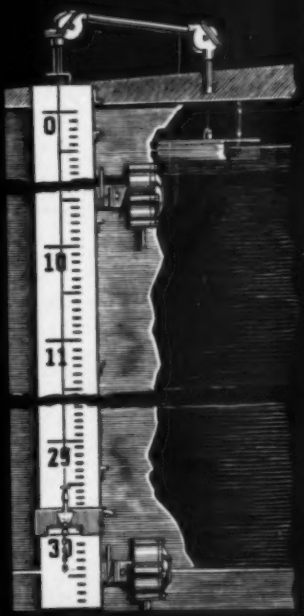

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By being careful in selecting a good tube for your condensers in the first place, you can reduce tube breakdowns—and consequent downtime, which is always costly.

By installing Wolverine condenser tube—the tube that is quality-controlled from ore to finished product—you relieve yourself of much worry. You can rely on its giving dependable performance far above average expectancy.

Always specify Wolverine tube for your condensers and heat exchangers, thus making sure that the tube you select is of the proper copper base alloy which will meet the conditions peculiar to your operations. If you require any assistance in making such selections, feel free to call on us. We're always ready to help.

WOLVERINE TUBE DIVISION
Calumet & Hecla Consolidated Copper Company
INCORPORATED
Manufacturers of seamless, nonferrous tubing
1431 Central Avenue • Detroit 9, Michigan

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y. AD No. 1-3096

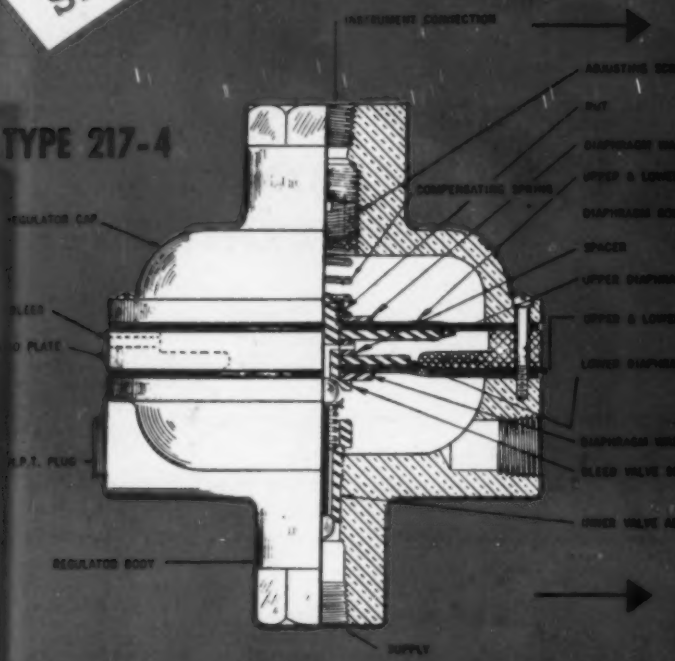
STEP-UP

SPEED-UP

SLOW-UP

VALVE ACTION *with* BS & B CLIMAX RELAYS

TYPE 217-4



For almost any pressure, input or output variation in the supply medium to the control valve, there's a Climax Relay to do the job efficiently and accurately. You can deliver pressure output to step up action, boost the capacity of low-limit controls to handle larger loads, speed the valve loading or reduce it, eliminate pressure lag on long supply medium lines, control high steam pressures with balanced diaphragm regulators.

New BS&B Climax Relays are being constantly developed to meet the demands of the latest methods and equipment. Their accuracy and sensitivity will contribute much to the efficiency of your processing system. They will, in many cases, provide a great economy by permitting your valves and controls to expand their designed functions.

Write for Catalog Section 119—"Relay Regulators." Illustrated, complete with descriptions, applications and installation data.

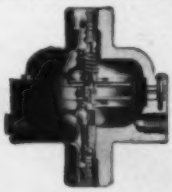
CLIMAX BS&B CONTROLS

BLACK, SIVALLS & BRYSON, INC.

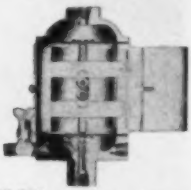
Climax Controls Division Dept. 4-F4

7500 East 12th St. Kansas City 8, Missouri

NEW TYPE 227 Delayed action, fixed ratio. Permits full valve travel with standard diaphragm pressure ranges on series-operating diaphragm control valves in combination with type 217-2B relay.



TYPE 217 Fixed Ratio—to meet demands of control pressures beyond the range of usual instrument pressures; permits low-limit controls to secure higher loading pressure.



TYPE 224 Variable Ratio—creates a loading of pressure balanced diaphragm valves to permit the control of high steam pressures in reboilers or fractionating kettles, where steam pressures must vary for varying products.

NEW TYPE 228 Reverse Action Relay for maximum pressure output at minimum input—or vice versa. Or, in bypass installation, reverse valve action in relation to pilot action, when occasionally required.

TYPE 209 1 to 1 Ratio—will eliminate air exhaust and input pressure lag where long supply medium lines are used.

Hand-tailored to any size you need...

...Goetze Heat Exchanger Gaskets are precision-made for longer service

Whether your requirements call for heat exchanger gaskets larger than 100" in diameter, or smaller than 10", you can get the exact size you want... hand-tailored to the shape you need... simply by specifying "Johns-Manville Goetze."

And because they're *precision-made*, you'll find these better gaskets provide the effective sealing and longer life that make them actually cost less in the long run. Each gasket is carefully constructed in every detail to assure accuracy of fit ... to provide ample lap widths and uniform rib widths... and to prevent trouble-making wrinkles or cracks on the corners.

If you're having trouble with persistent joint leakage and frequent gasket replacements, find out how little it costs to have Goetze Heat Exchanger Gaskets tailored to your requirements. Your blueprint or template will bring a prompt estimate. Address Johns-Manville, Box 60, New York 16, New York.

Johns-Manville *Goetze* GASKETS

THERE'S A JOHNS-MANVILLE PACKING AND GASKET FOR EVERY SERVICE

PHILADELPHIA SPIRAL-BEVEL COOLING TOWER DRIVE

The growing use of larger fans in cooling tower service brought the need for a drive that would best meet heavier load conditions. Philadelphia, having long been a leading manufacturer of conventional worm gear cooling tower drives, thoroughly understood this problem.

Our solution: An entirely new spiral bevel-helical drive.

This new unit is extremely compact, yet sturdy of construction. Units available in a wide range of sizes and ratios.

For assurance of dependable operation, long life and high load transmission specify a Philadelphia drive.

Design and construction features are in Bulletin CT-51. Write for a copy on your business letterhead.

"60" ANNIVERSARY

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

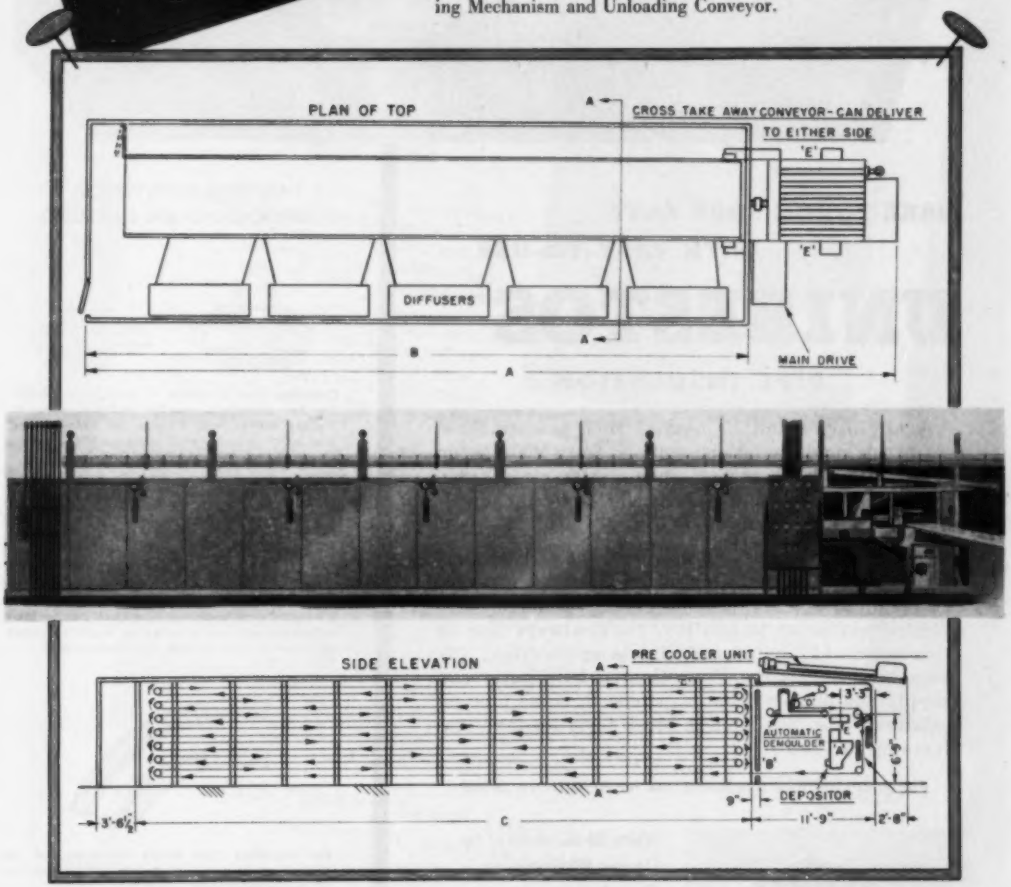
THE GREER AUTOMATIC WAX MOULDING MACHINE

THE GREER CONTINUOUS WAX MOULDING MACHINE is a completely automatic machine for processing liquid wax into finished slabs. This production-proven equipment is an adaptation of machines which have been manufactured for many years by the Greer company for chocolate manufacturers.

Basically, the Wax Moulding Machine has been designed to perform, automatically, a series of essential operations. First, it receives liquid wax from storage tanks and precools it to controlled depositing temperature. It then deposits the wax in moulds and cools the resulting slabs to a solid state. Finally, it de-moulds the slabs (10½ lbs. each). Weights other than 10½ lbs. can readily be obtained.

The size of the machine to produce 15,000 lbs. per hour is only 90 feet long, 20 feet wide and 11 feet high. Supervisory help only is required.

The machine consists of five basic units: A Pre-cooling Unit, A 6-Cylinder Volumetric Depositor, A standard Greer Multi-Tier Conveyor, A Refrigeration Bunker Box, and An Automatic Demoulding Mechanism and Unloading Conveyor.



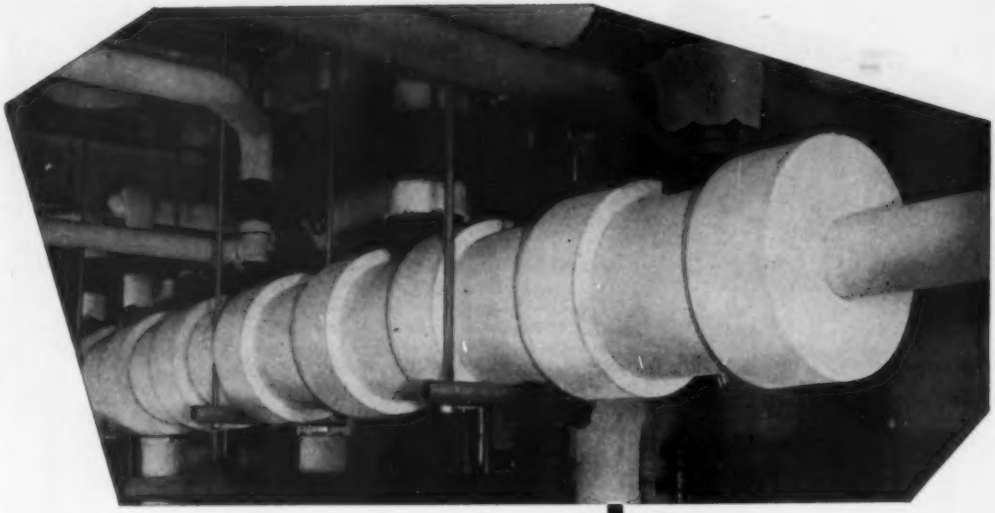
J. W. GREER COMPANY

Write today for Bulletin 51-2.

119 WINDSOR STREET, CAMBRIDGE 39, MASSACHUSETTS

Sales Engineering Offices: New York, N. Y., Chicago, Ill., San Francisco, Calif.

GREER



MAKE TOUGH JOBS EASY
WITH EASY-TO-USE

UNIBESTOS®

PIPE INSULATION

Ask any user about Unibestos! He'll tell you how easily this good insulation is cut and fit on-the-job, for Unibestos is light, strong, firm—saws cleanly for tight joints—retains initial high efficiency. It is unaffected by service hazards.

Whether you specify Unibestos No. 1200 (for temperatures up to 1200°F.), Unibestos No. 750 (for temperatures up to 750°F.), or Amocel for commercial uses (temperatures up to 600°F.), you'll always save in two ways: (1) quick and simple application; (2) long-lived durability. Your Unarco Distributor can supply you quickly from his stocks of these pipe insulations. Also available in block form for temperatures up to 1200°.

For details on these insulations, ask for Bulletin No. 76-109.

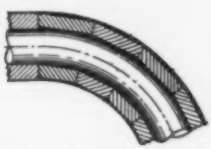
UNARCO

Write for the name of the Unarco Warehousing Distributor in your area.

SEE HOW THESE TYPICAL APPLICATIONS ARE SIMPLIFIED

Unibestos pipe insulation is particularly adaptable for insulating irregular surfaces such as flanges, valves, and fittings. Its firmness and easy-to-fit characteristics make such jobs easy; save time.

Unibestos pipe insulation and block can be used separately or in combination for insulating nested and traced lines quickly and economically.



For insulating pipe bends Unibestos can be mitered easily, and cemented-in with Unarco No. 50 insulating cement.

UNION ASBESTOS & RUBBER COMPANY

DEPT. D-4 • 332 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS

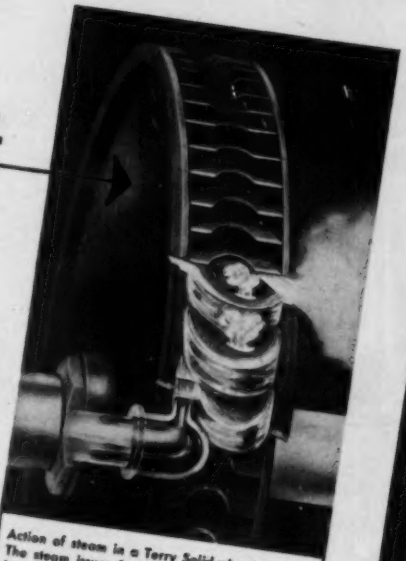
TERRY

THIS TURBINE WHEEL

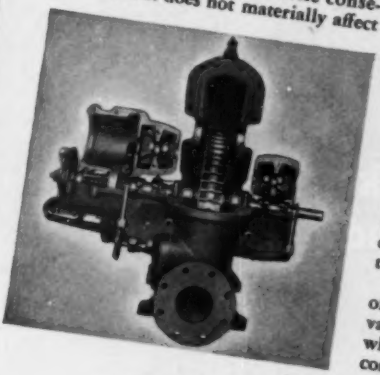
has no parts to loosen or work out

The rotor of the Terry Solid-wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Hence, wear of the blades is of little consequence, as it does not materially affect horsepower or efficiency. There is practically no end thrust since the steam enters and leaves the wheel in a direction at right angles to shaft.



Action of steam in a Terry Solid-wheel Turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.



This is only a small part of the story of the many advantages of the Terry Solid-wheel Turbine. Write for complete details.

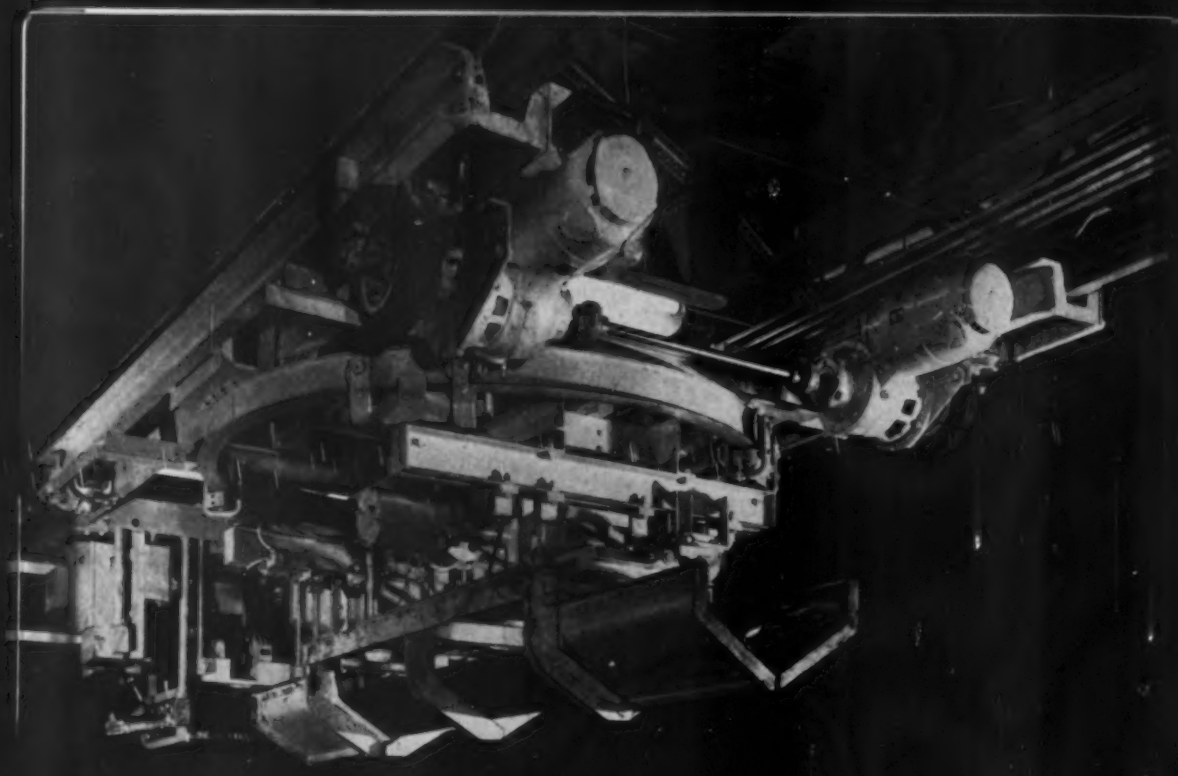
THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

TT-1189

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.



You can't beat the combination of the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features all in one compact unit that you can use RIGHT where you want it. It's the best way and the easiest way to select your power drives because you purchase one unit, handle one unit in your receiving, production, and maintenance departments . . . set one unit in place and you're ready to go.

Master Motors, available in thousands and thousands of combinations of types and ratings, permit you to use a power drive that will add greatly to the compactness, appearance, and economy of each of your applications . . . a power drive that makes a good job better.

Use Master Motors to increase the salability of your motor-driven products . . . improve the economy and productivity of your plant equipment. They're the horsesense way to use horsepower.

THE MASTER ELECTRIC COMPANY

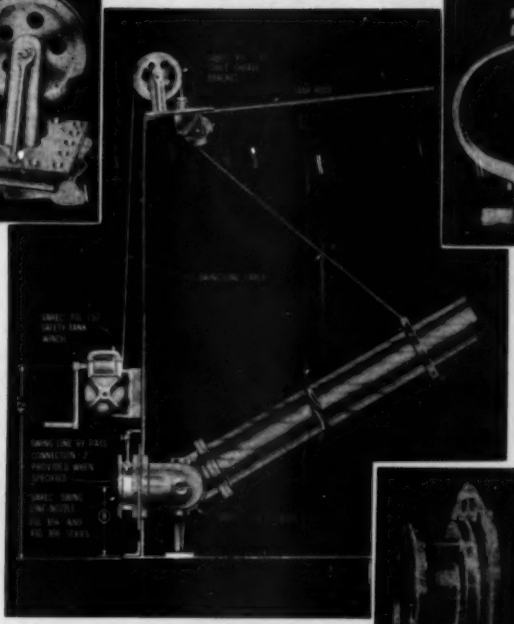
DAYTON 1, OHIO

makes a good job better

For A Safe, Serviceable Swing Line Assembly

SPECIFY "Varec" PROVED and APPROVED **EQUIPMENT**

"VAREC" Cable sheave Bracket equalizes pull in both directions. Pull is straight down on either side to eliminate all angularities.

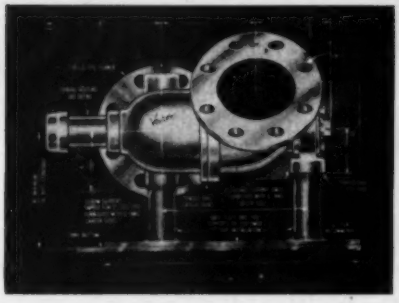


"VAREC" Cable Collar Clamps provide a simple, foolproof means of connecting swing line cable to swing line pipe.

"VAREC" Safety Tank Winch dependably sustains loads without use of clutches or dogs. Enclosed worm and gear drive. 1500, 2500 and 5000 lb. capacities.

"VAREC" Double or Single (shown above) Swing Line Assemblies afford the utmost in safe, reliable and trouble-free operation.

"VAREC" Tank Shell Nozzles provide a rigid, leak-proof connection between inside swing joint and outside valve or pipe line. Extra heavy, hydrostatically tested.



"VAREC" Swing Joints facilitate raising and lowering swing lines inside storage tanks. Patented control sleeve prevents elbows from parting under any condition.

"VAREC" Swing Line Equipment in addition to affording many important operating conveniences is built for extra years of dependable, trouble-free service with safety. Each component part is made with extreme care to eliminate servicing of both internal and external parts.

"VAREC" Engineering Department and Testing Laboratory will gladly collaborate with you on any problems regarding Swing Line Equipment, so when the "specs" say Swing Line, specify "VAREC" for satisfactory service and safety.

"Varec" PROVED and APPROVED

THE VAPOR RECOVERY SYSTEMS COMPANY
COMPTON, CALIFORNIA, U. S. A.
Cable Address: VAREC COMPTON USA (All Codes)
New York — Boston — Pittsburg — Chicago — Detroit — St. Louis — Houston
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That's entirely logical. Every refinery executive knows that a reforming job *must be done by a reforming process.* With that need in mind, Platforming was developed to provide the most efficient method of reforming low octane gasoline stocks into high octane products.

There are various jobs in a refinery that require a number of different processes. Where reforming is needed, Platforming fits the requirement perfectly. It is a true reforming process . . . specifically designed, engineered and constructed to meet the particular needs of that job.

The number of Platforming units now operating, and the acceptance accorded Platformed gasoline at the point-of-sale is certainly convincing proof of Platforming's success in doing the job for which the process is intended.

UNIVERSAL OIL PRODUCTS COMPANY

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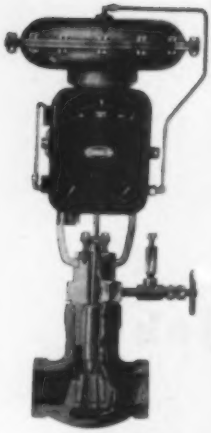
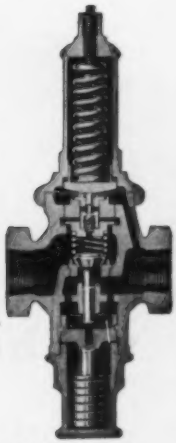
Universal Service Protects Your Refinery



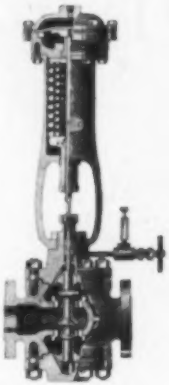
#2707-137-5
Pressure Controller (3000# W.P.)
Spring Opened
(#138-5 Spring Closed Available)

#138-2 Control Valve
w/positioner & airset
air-to-open
(#137-2 air-to-close available)

#137-2 Control Valve
Percentage Parabolic Trim
(#137-3 V-Port available)



#11 Steam Reducing
(5-225# Outlet)



#35 Reducing
#36 Back Pressure

MASONEILAN REGULATORS

For Gas, Air, Steam, Water or Oil Service

See "MAINTENANCE" about your Control Problems

Our application engineers will understand your needs and recommend most suitable regulator for the job.

IMMEDIATE SHIPMENT of

Regulators
Liquid Level Controllers
Diaphragm Control Valves
Parts

from LARGE HOUSTON STOCKS

#12600 Series Liquid Level Controllers, Torque Tube Type (No Packing)

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ENGINEERING CORPORATION
3611 CLINTON DRIVE
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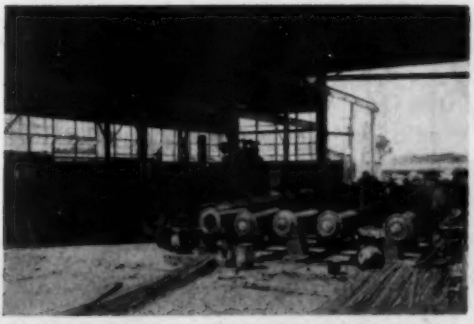
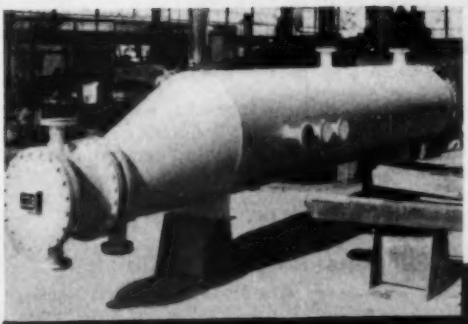
EQUIPMENT WITH ENGINEERING SERVICE
MECO

HEAT EXCHANGERS

The very highest quality petroleum and chemical heat exchangers are here portrayed in the making.



- DESIGN
- FABRICATION
- REPAIR

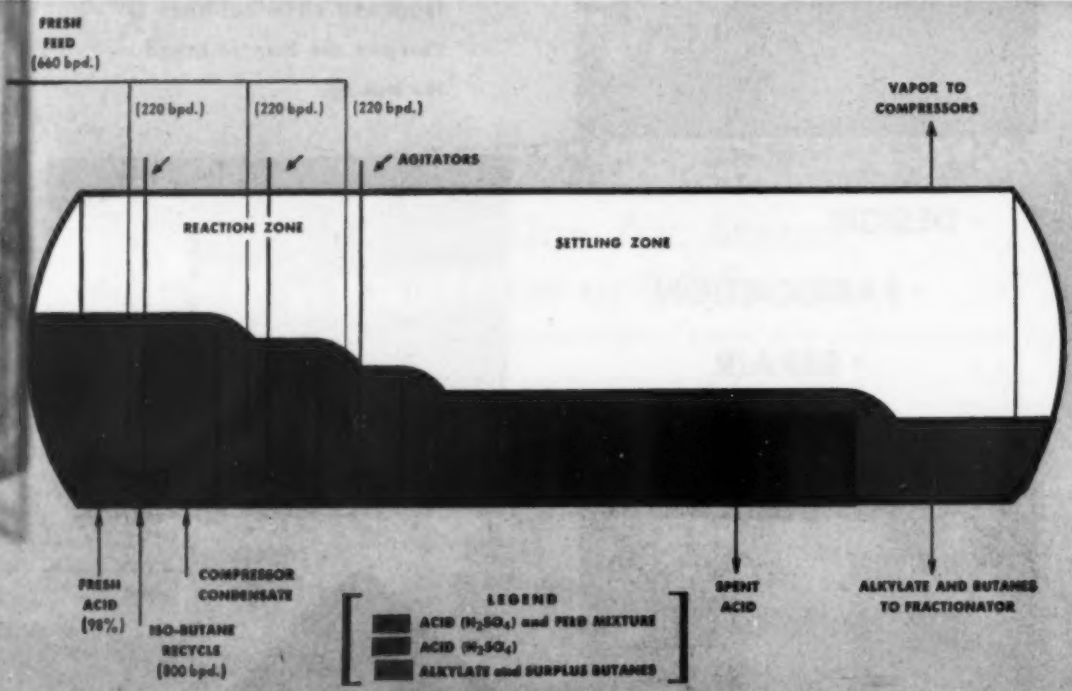


Your inquiries are cordially invited.

TEXAS METAL FABRICATING COMPANY

HOUSTON

This NEW Kellogg-cascade reactor initial cost



How New Reactor Maintains 9-to-1 Isobutane-Butylene Ratio

Assume, as a simplified case, that fresh feed is charged to the reactor shown here at 660 barrels per day. This feed, comprising a mixture of approximately 300 barrels of butylene and 360 barrels of isobutane, is divided into three equal 220 BPD portions, each of which is introduced into one of the three reaction sections.

To increase the amount of isobutane at the points of reaction, a recycle stream of isobutane from the unit's main fractionator is fed in at the bottom of the first section. This recycle must be at a rate of 800 BPD to provide the desired isobutane-butylene ratio.

Adding up the total amount of isobutane in the first reaction section, we find there are 920 barrels to 100 barrels of olefin. Since only about 110 barrels of the isobutane reacts with the total olefin present, about 810 barrels of excess isobutane are carried over into the second section where the cycle starts over again.

Thus, while the total amount of olefin charged each day to this reactor is 300 barrels and the total amount of isobutane is 1160 barrels (a ratio of about four-to-one), the actual ratio at all reaction points is better than *nine-to-one*.

designed brings lower to sulphuric acid Alkylation...

SULPHURIC ACID alkylation has long been recognized as a vital process in the production of high octane avgas and a valuable tool for upgrading a refinery's motor gasoline pool.

Now several Kellogg design innovations have been incorporated in this process which reduce the initial investment required, as well as the daily operating costs, for the production of a given quality and quantity of alkylate.

The most important improvements have been made in the reactor itself. With the new Kellogg cascade reactor, a highly desirable nine-to-one ratio of isobutane to butylene is maintained *in the reaction zones*—although the overall isobutane *feed* to the reactor is less than four-to-one. While increasing the yield and improving the quality of alkylate, this new design also materially reduces the number of pumps and permits use of smaller vessels than would otherwise be required to attain a high isobutane-butylene ratio.

In addition, the cascade flow of acid and fresh feed in successive stages radically improves the economics of acid consumption. When feeding 98% sulphuric acid to the new Kellogg units, the acid concentration can be maintained at an efficient average of 91.5% in all reaction zones, while the withdrawal concentration is kept at a low 88%.

Add to these advantages the low horsepower requirements of propeller-type agitation and the savings inherent in auto refrigeration cooling . . . and it is evident why many refiners are exploring the possibilities of modern sulphuric acid alkylation.

New Kellogg-Designed Units

UNITS OPERATING

In the Midwest—2500 BPD unit
In the Southwest—1000 BPD unit
On the Atlantic Seaboard—2200 BPD unit

UNITS UNDER CONSTRUCTION

In Texas—1200 BPD unit
In South America—1600 BPD unit

UNITS IN ENGINEERING

On the Atlantic Seaboard—3500 BPD unit
In Texas—1200 BPD unit

For further information, yield and inspection data, etc. write

THE M. W. KELLOGG COMPANY

(SUBSIDIARY OF PULLMAN INCORPORATED)

for fifty one years an integral part of petroleum refining progress!

KELLOGG

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

FACT

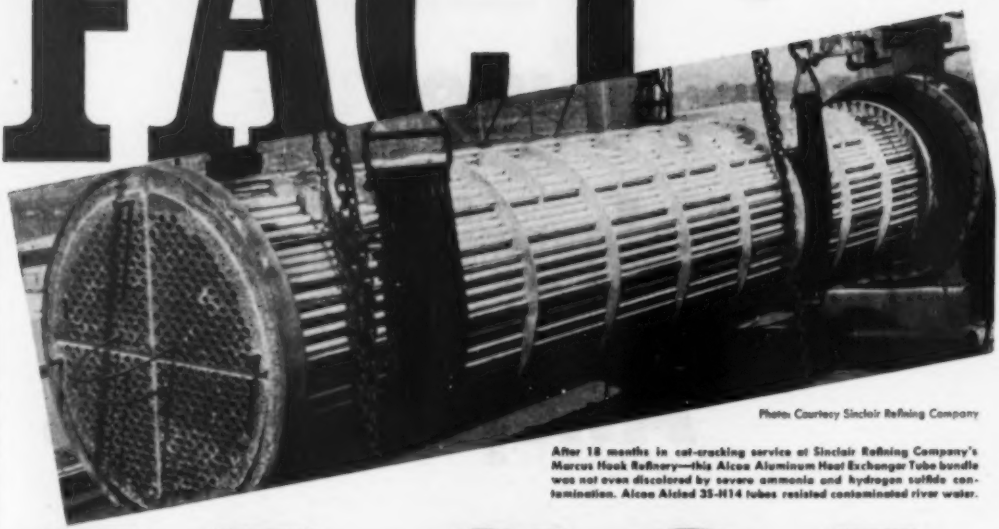


Photo Courtesy Sinclair Refining Company

After 18 months in cat-cracking service at Sinclair Refining Company's Marcus Hook Refinery—this Alcoa Aluminum Heat Exchanger Tube bundle was not even discolored by severe ammonia and hydrogen sulfide contamination. Alcoa Alclad 35-H14 tubes resisted contaminated river water.

ALCOA

knows most about the use and application of aluminum heat exchanger tubes

Alcoa pioneered the use of aluminum in heat exchanger tubes 43 years ago. Although their sale today is limited by government regulation, you will want to start planning with a copy of the booklet, "Alcoa Aluminum Heat Exchanger Tubes." Write:

ALUMINUM COMPANY OF AMERICA • 1867D Gulf Building, Pittsburgh 19, Pa.

OVER 6-MILLION FEET OF ALCOA TUBES ARE IN USE FOR APPLICATIONS LIKE THESE . . .

PETROLEUM

Condensers handling hydrocarbon fractions from such processes as Thermal and Catalytic cracking, reforming, polymerizing, etc.
Vapor recovery condensers
Lube oil coolers
Natural gas compressor aftercoolers
Recompressor aftercoolers
Hydrogen sulfide gas coolers
Furfural condensers and heat exchangers
Propane chilling
Wax sweaters
Lean oil—rich oil exchangers
Amine solution coolers
Glycol-amine heat exchangers and reboilers
Jacket water coolers

CHEMICAL

Butanol
Ethanol
Ethylene Glycol
Glycerin
Hydroabietyl
Isopropanol
Methanol
Phenol
Propylene Glycol
Acetaldehyde
Formaldehyde
Furfural
Heptaldehyde
Acetic acid
Stearic, Palmitic, Maleic Oleic acids
Butyric acid
Naphtha
Ricinoleic acid
Acetanilide
Ammonia
Hydrogen Cyanide
Nitric acid (concentrated)
Pyridine
Hydrogen Sulfide
Benzene
Dichlorobenzene
Gelatin
Hydrogen Peroxide
Turpentine
Xylene

Use Alcoa Alclad 35-H14 Heat Exchanger Tubes with fresh, brackish and salt-cooling waters

Get

something extra

when you buy

lead valves

Do you look for sturdiness, dependability, and suitability in the lead valves you buy?

Do you expect valve type, size pattern and flanging to meet your acid handling equipment specifications?

Of course you do! And when you order National you *get* what you look for. You *get* what you expect. And you get certain "extras" besides... extras that spell highest quality.

For example, National Lead valves have precision, lathe-turned stems. They have full flow-ways. They're designed to permit repacking in service. And they have positive plug-seat fit.

Fabrication extras... design extras... quality extras... Yes! And these extras you get, but never need specify, add up to outstanding service on the job.

That's why it pays to buy National valves ...for something extra in lead.

New York 6; Atlanta; Baltimore 3; Buffalo 3; Chicago 8; Cincinnati 3; Cleveland 13; Dallas 2; Philadelphia 25; Pittsburgh 12; St. Louis 1; Boston 6 (National Lead Co. of Mass.); Los Angeles 23 (Morris P. Kirk & Son, Inc.); Toronto, Canada (Canada Metal Company, Limited)

* Reg. U. S. Pat. Off.

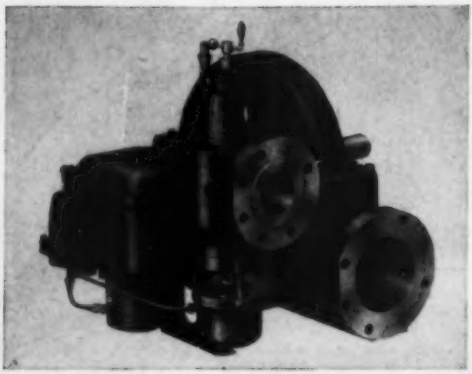
Lead valves

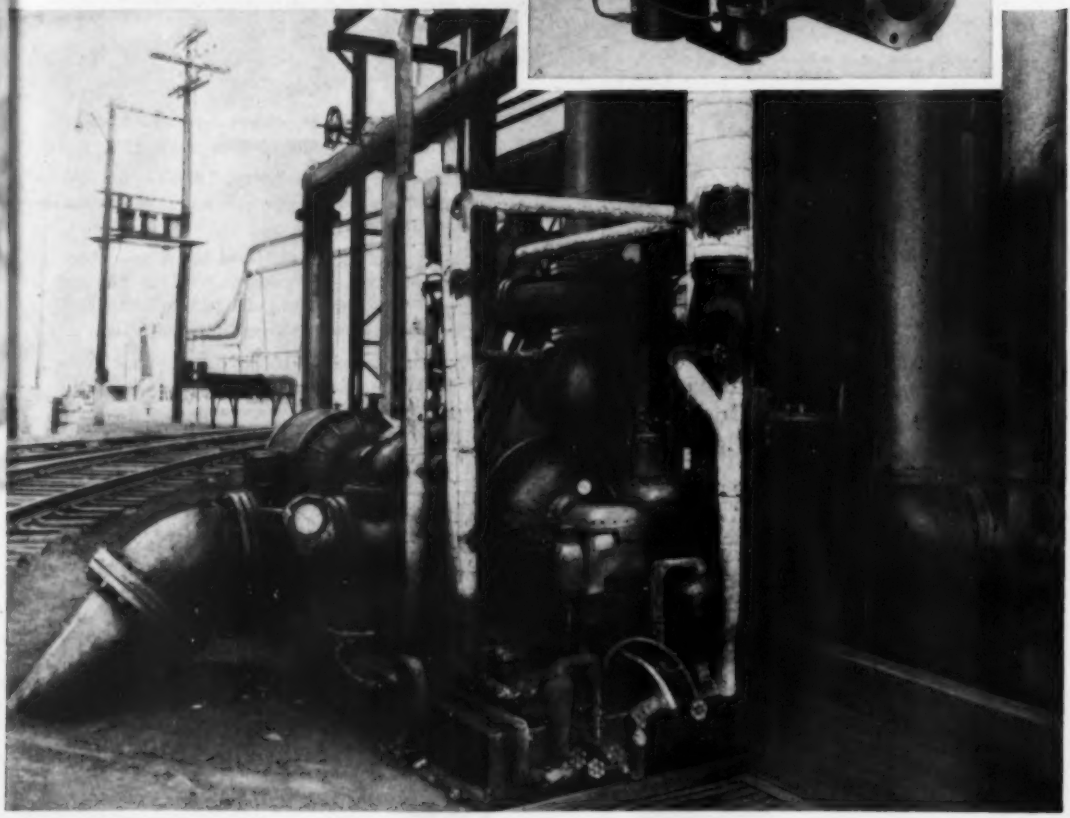
with a NATIONAL reputation

LEAD COMPANY

in turbine drives
Hydraulic Governing

TYPE DP TURBINES





OUTDOOR INSTALLATIONS, such as this one in an oil refinery, are taken in stride by the DP—another advantage of the totally enclosed, hydraulic governing system. Weather conditions and corrosive atmospheres don't bother the sealed-in unit.

DP means Dependable Power

Means Dependability

No part of a mechanical-drive turbine has more to do with day-to-day dependability than the governor. And in most installations, dependability is something that comes ahead of all other considerations—something you're willing to pay a little more to get.

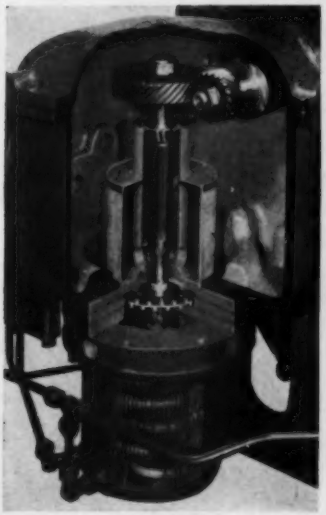
That's why General Electric standardized three years ago on hydraulic governing for its small, mechanical-drive turbines. The Type DP has the same kind of governor that's used with large, utility-type turbines. The operating record of hundreds of DP's in service throughout the country testifies to the soundness of this design.

It eliminates such elements as push rods, thrust bearings, knife-edges, etc., which are subject to wear and maladjustment. The governor operates in a totally enclosed oil atmosphere which protects parts from corrosion and rust.

Sometimes, turbines are used as standbys and put in service only at irregular intervals. Hydraulic governing eliminates the possibility of gumming and sticking during long periods of idleness—the DP is ready to go at a moment's notice.

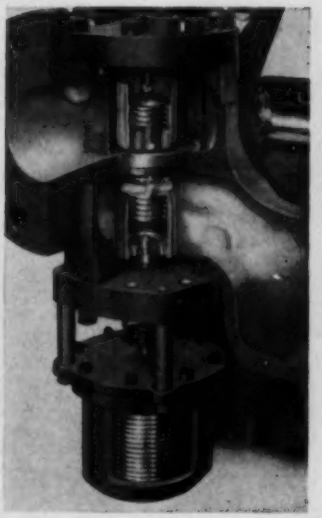
Performance-wise, the DP provides a 30% adjustable speed range—adequate for most applications. If you need more, the Type DR is available with a 6 to 1 speed range. Ask your nearby General Electric sales engineer for complete DP details. *General Electric Company, Schenectady, N. Y.*

HOW THE DP GOVERNOR OPERATES



This turbine-type oil pump, gear driven from the main shaft, signals any variation in the turbine speed due to changes in load. The pump also provides oil pressure for positioning the governor valve.

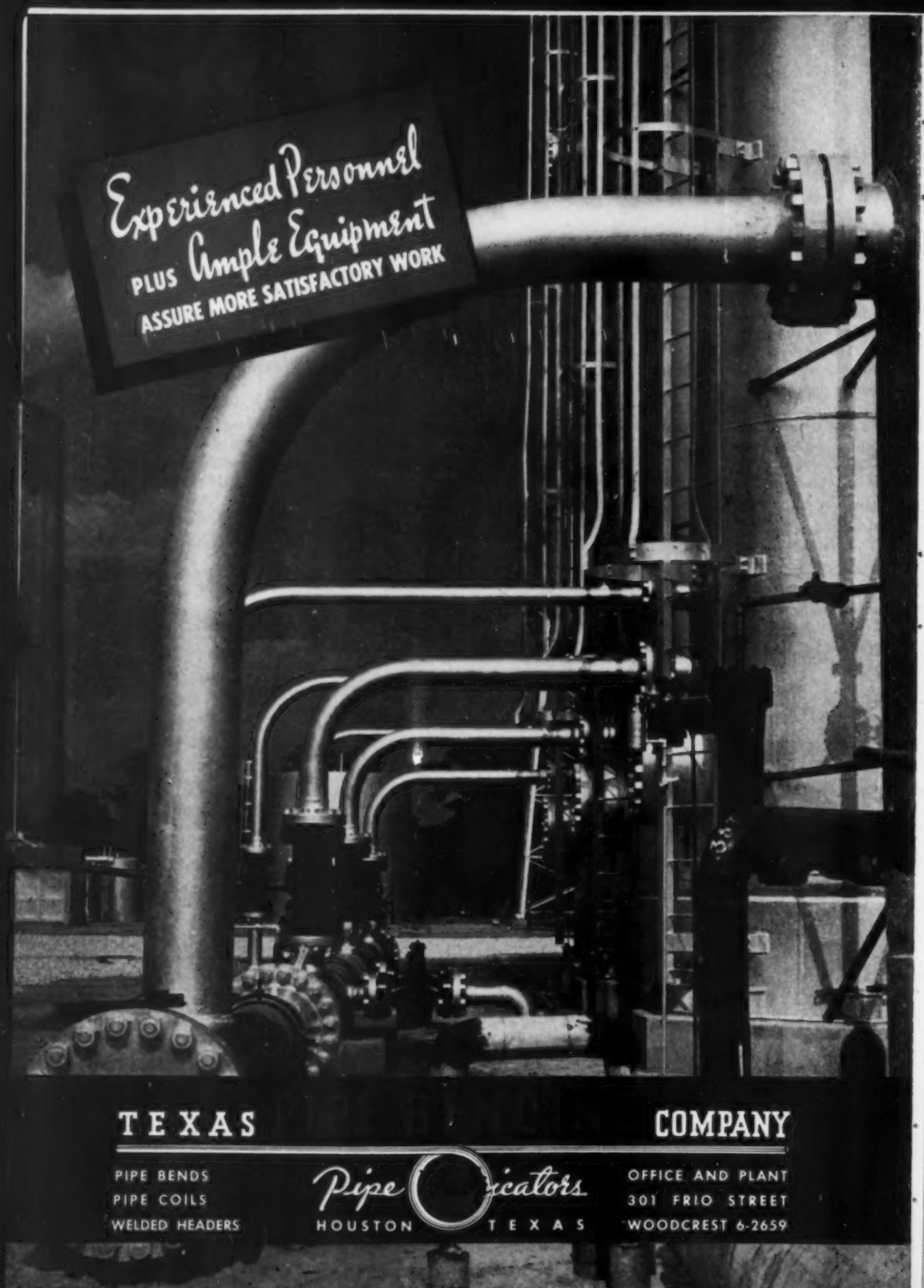
Acting on the speed signal from the oil pump, this pressure relay controls the amount of oil pressure in the operating cylinder. The pressure relay operates automatically after being hand set by the operator.



The operating cylinder, controlled by the relay, opens and closes the governing valve, thus regulating the steam admitted to the turbine. This system almost completely eliminates the need for moving parts.

GENERAL ELECTRIC

212-51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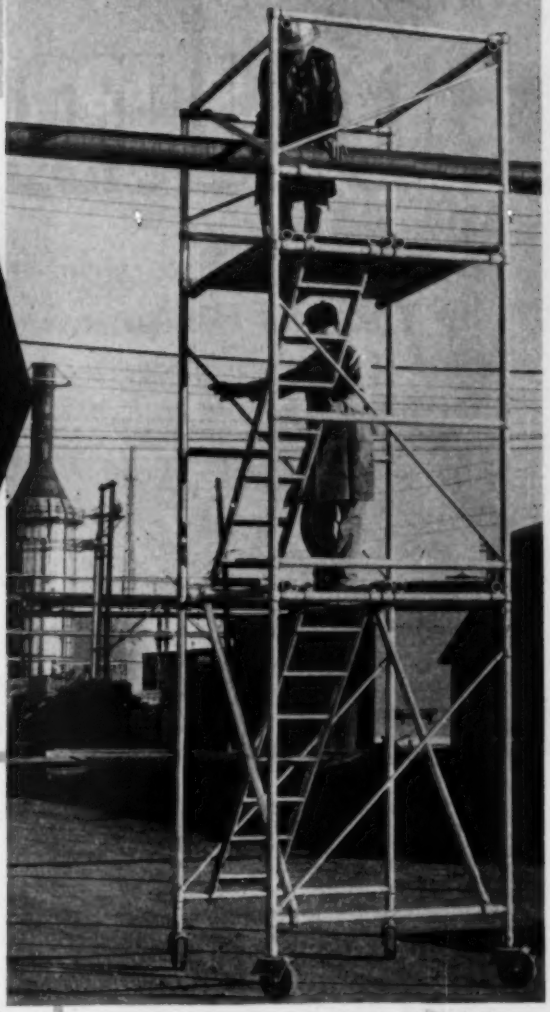
Presto... it's UP!

14 ft. "UP-RIGHT" SCAFFOLD-ON-WHEELS set up in only 3 minutes!

Esso Standard Oil Company
Louisiana Division • Baton Rouge, La.



As if by magic, an aluminum alloy tower of any height desired is ready in minutes! Individual scaffold sections are set one on top of the other. Sections lock into place instantly.

HERE'S THE SECRET!...

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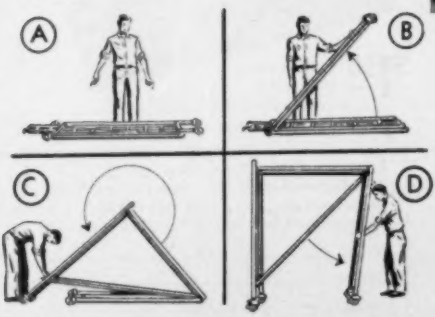
Each one-piece section is unfolded by one man in less than a minute! No tools, wing nuts or bolts.



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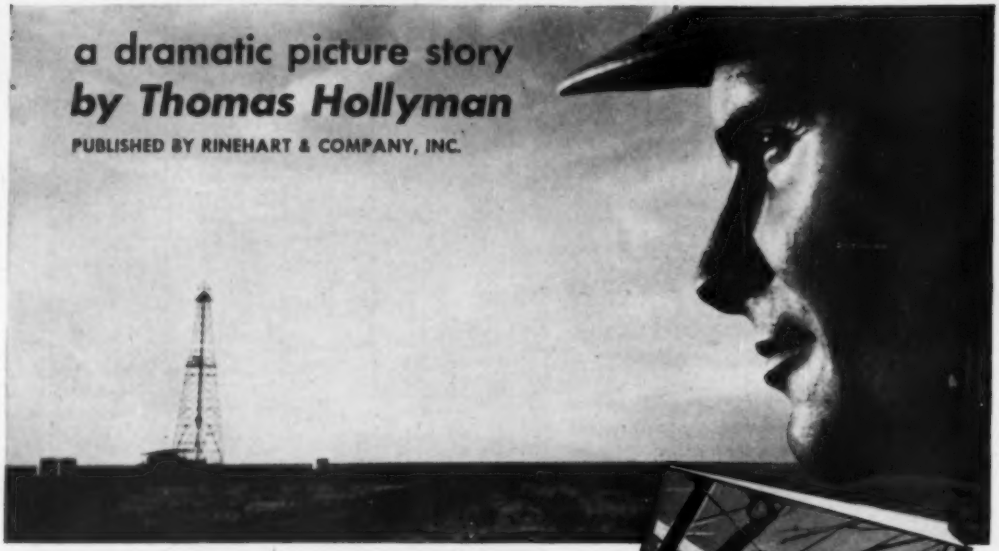
"The Oilmen"



It's a book you'll use hundreds of times —the picture story that captures the personality of an industry

● Consulting photographic editor of *Holiday*, and a contributor to other top magazines, Tom Hollyman now turns his lens on *oil*—to tell its exciting story in terms of the industry's men and women.

Dramatically photographed, concisely written, clothbound and oversize, "The Oilmen" tells petroleum's full story from search to discovery...through production, refining, transportation, marketing... to the ultimate user's door. It's a book the industry has needed for years, a book that every man and woman associated with petroleum must see, read, own.

$1.50 ACTUAL SIZE 10½" x 10¼"

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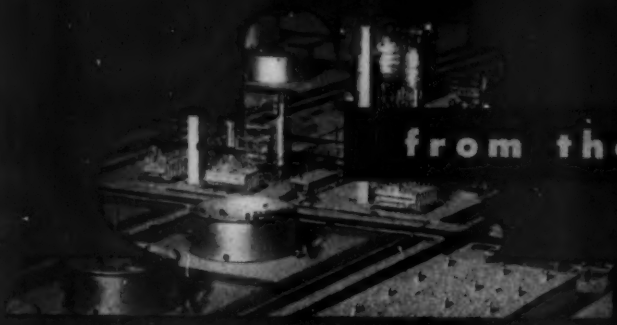
Shell Oil Company and its employees co-operated with Mr. Hollyman to make this picture story possible—and offer this announcement as a service to the men and women who have made oil the nation's No. 1 source of energy.

"The Oilmen," published by Rinehart & Company, Inc.
First Edition available May 1, 1952

new products



from the refinery

Ethylene . . . Aromatics . . . Hydrogen . . . Sulfur . . . Ammonia . . . Alcohols

These products are now being made in petroleum refineries.

Foster Wheeler's integrated engineering and construction organization has served both the petroleum and chemical industries for over 30 years in the design and construction of process units and complete refineries and chemical plants.

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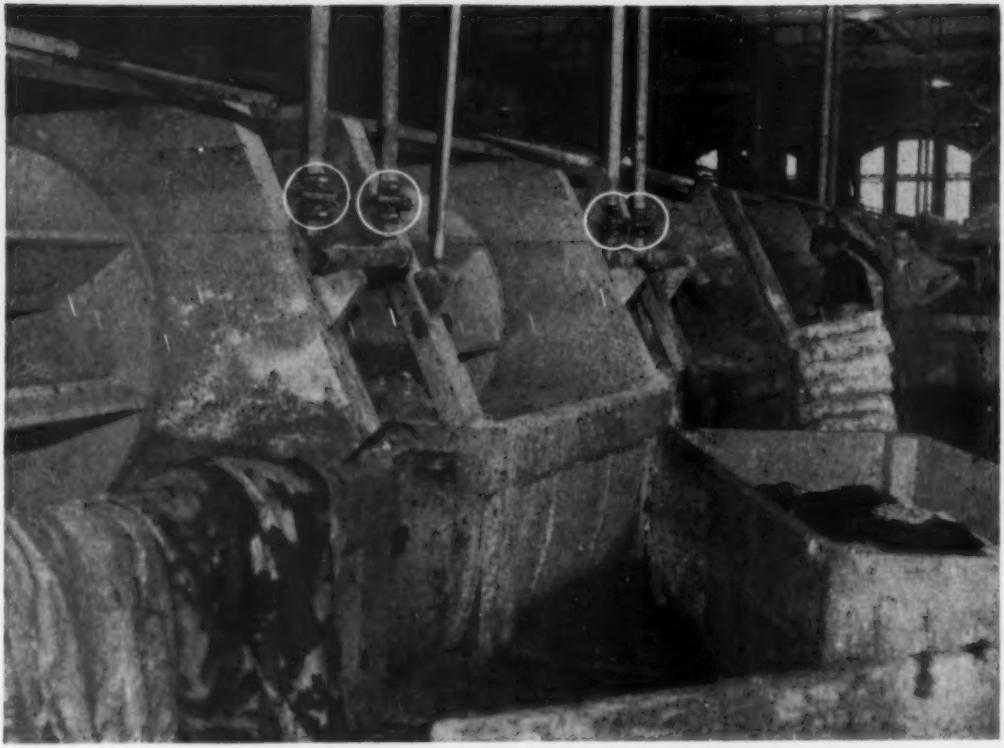


IN THE BEAMHOUSE above, Rockwood Ball Valves proved their worth in service. This tannery process removes hair from hides through "liming." Valves must be opened and closed constantly, must resist lime and acid vapors.

"Quickest, easiest valves to open and close,"

REPORTS TANNERY

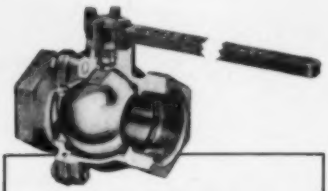
"They're sure built to take it," declares Cornelius Baltas, foreman of the Beamhouse, Creese and Cook Company. "And the Rockwood Ball Valve helped speed production, too. My men found them easy to get at, quick to open, quick to close—a big feature when opening and closing occurs all day long."

In this tannery installation, Rockwood Ball Valves carried water at 200° F to 220° F into lime paddle. Being leakproof, they prevented costly damage to hides from hot water . . . also proved resistant to strong lime and acid vapors that attack metals.

YOU, TOO, CAN BENEFIT

Tough tannery conditions are among many in which the use of Rockwood Ball Valves proves invaluable. Thousands of these valves are providing outstanding service in oil refineries, food, paper, textile, chemical, and rubber plants. Used in lines handling all types of liquids and gases, such as carbon dioxide, nitrogen, paraffin and asphalt base petroleums, alcohol and others. Available in bronze in pipe sizes from ⅛" to 2" and in cast steel from 3" to 4". Recommended for 300 psi working pressure. Approved by Underwriters' Laboratories, Inc.

If you are not already using Rockwood Valves, plan now to benefit from them. For further details, write for Bulletin V-4 today. Get complete data including prices and applications.



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- **FULL ROUND FLOW**
- **QUICK OPENING AND CLOSING**
- **NO MAINTENANCE**

Distributors in all principal cities

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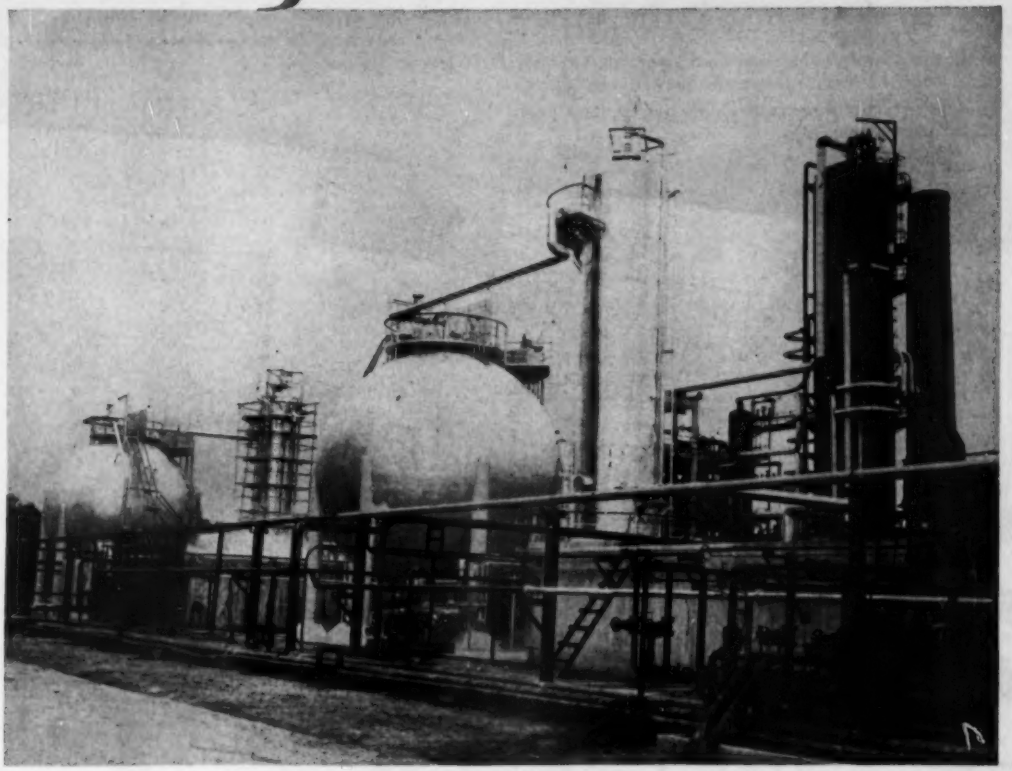
ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY, 102 HARLOW STREET, WORCESTER 5, MASS.

CITIES SERVICE } another leading refiner desalts with PETRECO



Cities Service has long been recognized for progressive leadership, dependable excellence of product and refining know-how. The first Petreco Desalter for Cities Service was installed in their East Chicago, Indiana, refinery. When their great new refinery at Lake Charles, Louisiana, was built, Petreco Desalters were installed as part of the regular refining flow system.

There is only one way to earn a *repeat* installation for a company such as Cities Service, and that is to produce results the first time. In this particular case the Petreco Electrosphere to the right in the picture above has delivered throughputs as high as 75,000 barrels per day for extended periods of time and was a considerable factor in the topping units continuous fifteen months run during which 30,000,000 barrels of oil were processed. Results such as these are the reasons why leading refiners continue to specify Petreco Desalting and Petreco Service.

PETRECO PROVIDES COMPLETE DESALTING SERVICE AND FACILITIES

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SPECIALIZED Electric PETROLEUM PROCESSES { DESALTING / DEHYDRATING

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HERE'S AN EXAMPLE of how Armstrong data help you select the right size trap for the job:

Armstrong trap capacity figures are based on literally hundreds of tests under actual operating conditions with condensate at steam temperature. The choking effect of flash steam through the orifice as well as the back pressure created by flash steam were automatically taken into account. Actual hookups were used to allow for the effect of pipe friction.

If the capacity ratings had been based on cold water tests, which produce no flash steam they would be too high.

Orifice test ratings are too high because they ignore the effect of pipe friction.

Slide rule calculations of trap capacities have never been conservative.

WHEN YOU SPECIFY A STEAM TRAP you are specifying condensate handling capacity. When you use Armstrong Selection Data and specify Armstrong traps YOU KNOW that you are getting the right trap for the job.

Armstrong traps last longer, too—with less maintenance. And, they are *unconditionally guaranteed* to give complete satisfaction.

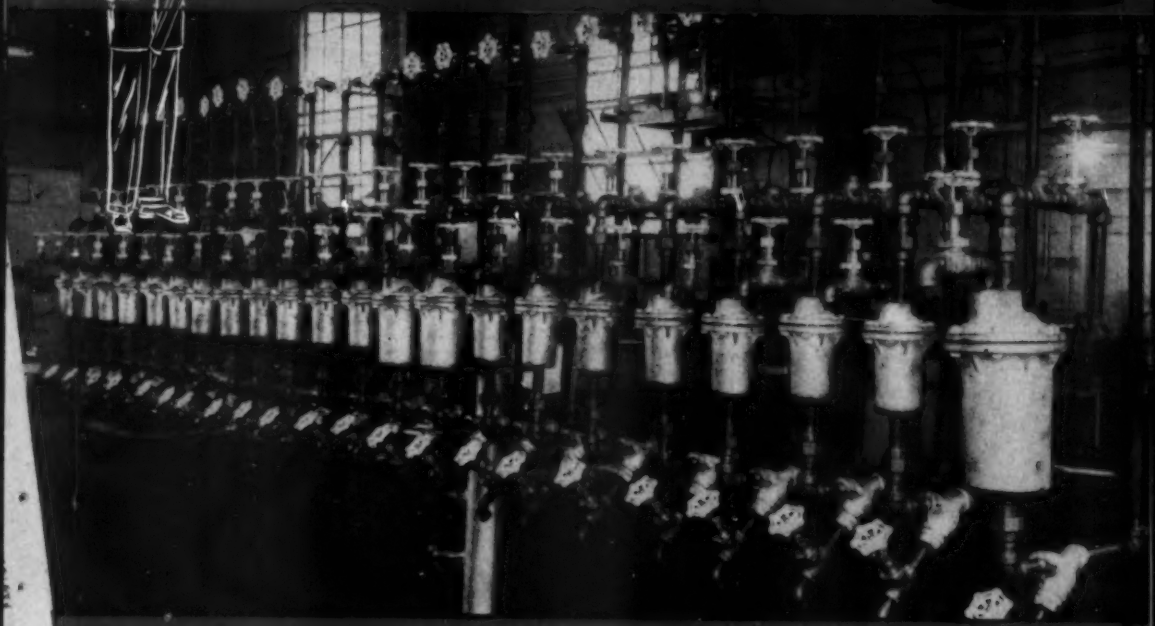
Pages 22 and 23 of the Armstrong Steam Trap Book.

You're getting a known quantity when you specify

ARMSTRONG

No trial and error on that job . . . .

ARMSTRONG TRAP DATA are Reliable



THE most carefully calculated installation of steam-heated processing equipment will fail to deliver full output if the steam traps do not have adequate condensate and air handling capacity. When this happens an important part of the capital investment in plant and equipment is wasted.

After you have figured the amount of steam that will be condensed, you need data on:

Condensate Capacity—not theoretical, not estimated, not cold water, but actual test findings with traps discharging condensate at steam temperature (see the discussion on the left-hand page).

Trap Capacity Safety Factors, or ratio between continuous discharge capacity and actual amount of condensate to be handled. These may run from a low of 2 to 1 or as high as 8 to 1. Armstrong data tells you just what safety factor to use to obtain adequate air venting capacity and maximum heat transfer.

Armstrong trap data helps you get traps "big enough" for the job, but not too big; assures you maximum operating efficiency; eliminates corrections after installation. For traps and trapping assistance call your nearby Armstrong Factory Representative.

Left—Side Inlet—Bucket traps for pressures to 250 lbs. for steam.

Right—Forged steel traps for pressures to 1500 lbs. screwed, socket or weld or flanged connections.

Left—Bottom Inlet—Top bucket traps for pressures to 250 lbs. for steam.

ARMSTRONG MACHINE WORKS

852 Maple St., Three Rivers, Michigan

Send for the NEW 44-page Steam Trap Book—

Including 14 pages of data on how to size traps for nearly every type of equipment. Sent on request—no obligation.

STEAM TRAPS

HAMILTON WATCH COMPANY

LABORATORY CHECKS ON MOISTURE IN COMPRESSED AIR

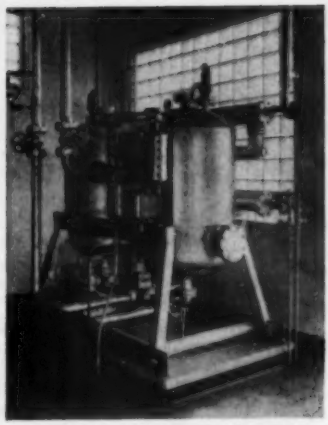
Date	Dep't	Dew Point	Grains/ cu. ft.	Remarks
4/20	Bal. & Flat S.	-50.0° C	.0124	Good
4/20	Works Lab	-50.0° C	.0124	Good
4/23	Bal. & Flat S.	-50.0° C	.0124	Good
4/23	Works	C	.0124	Good
4/27	Works Lab	+4.0° C	2.800	Poor NOTE: This situation produced when the new compressor was thrown into use without passing the air through the Lectrodryer.
4/29	Bal. & Flat S.	-54.0° C	.0082	Good
4/29	Works Lab	-54.0° C	.0082	Good
5/3	Oil capsule changed			

A lab man's notebook tells why you need Lectrodryers*

Page after page, the report on moisture conditions was "Good". Then *wham!* It jumped from a hundredth grain per foot of air to 2.8 grains. Howls of protest were heard all through this plant —"What's happened to our air?"

A new compressor had been placed in service, bypassing the old Lectrodryer. A quick switch was made and again the report became "Good".

Lab men's notebooks all over the world are telling this same story: Air is kept free of unwanted moisture by Lectrodryers, assuring dependable functioning of air-operated instruments. For help in determining what Lectrodryers will do for you, write Pittsburgh Lectrodryer Corporation, 307 32nd Street Pittsburgh 30, Pennsylvania.



The new Type BY automatic Lectrodryer gives you DRY air at minimum investment

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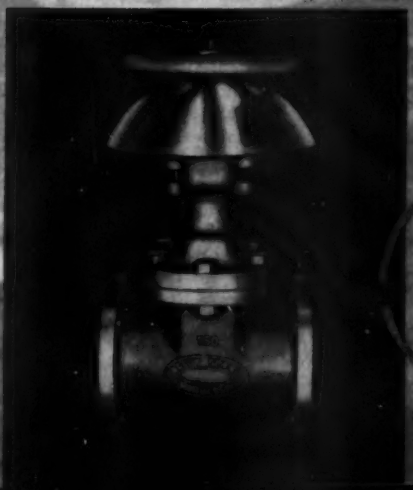
LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

Lasts longer in corrosive service

Like all ALOYCO valves, this acid-shield gate valve is especially engineered for severe corrosive service. Its dependable performance results from extensive metallurgical research and production of high alloy valves exclusively.



ALOYCO No. 111-A acid-shield gate valve is made in a wide range of analyses to specification and regularly stocked in popular alloys.

SUCCESS STORIES FROM ALOYCO'S CORROSION CLINIC

THE CORROSIVE: 93% and 98% sulfuric acid and oleum used in manufacture of white mineral oil and petroleum sulfonates.

THE APPLICATION: Acid control lines, temperatures 115 to 150 F.

THE VALVE: ALOYCO 20 gate valves, Teflon-packed.

THE RESULTS: Since ALOYCO valves have been installed, none have been repaired or even repacked. Cast iron or steel alloy trim valves formerly used for H_2SO_4 handling were usually removed from service after less than one year's use. ALOYCO valves are lasting four times as long, giving maintenance-free service.

THE BACKGROUND: ALOYCO valves are giving satisfactory service in many other installations in this refinery, just as they are in applications throughout the petroleum industry.

Cost and nuisance of frequent valve replacement have been eliminated by the use of ALOYCO valves especially developed for such service.

The *Aloyco Corrosion Clinic* is ready to go to work on your valve deterioration problem. Turn it over to them for "diagnosis" and "treatment".

Corrosion-resistant ALOYCO *valves outlast former valves four to one!*

ALLOY STEEL PRODUCTS CO., INC.
1303 West Elizabeth Avenue, Linden, N. J.

Longer Lasting
ALOYCO VALVES
1st in Corrosive Service

It took two railroad cars to provide "passenger accommodations" for this depropanizer tower—as Sun Ship workers readied it for shipment.

tough bronco—
PETROLEUM!

Ever see a bronco at the first touch of the saddle? Ever see a gusher well come in? The resemblance doesn't end with the furious first burst of action, even though the saddled pony stands quiet . . . and the stream of black gold pours placidly into the refinery—until man renews his taming process.

Breaking a fractious horse . . . cracking petroleum . . . makes them both useful. And both tasks throw the full test of pressure on the men who tackle the job . . . and on the equipment they use.

Tanks and towers . . . in fact all refinery and chemical equipment built at Sun Ship has been meeting the toughest tests of pressure through years of service. That's to be expected. The men of Sun Ship who build it have shown their ability to meet and master the production pressure of time . . . and the engineering and shipping problems that go with the task of constructing and delivering the gigantic equipment that helps build a greater and stronger America.

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After two years of development and test work confirmed in the operation of the large West Texas installation pictured at the right,

HUDSON

presents the

Combin-aire*

A New Type Cooling System Integrated for All Process Plant Cooling Services, Combining the Economical Maximum Use of Air With Minimum Use of Water.

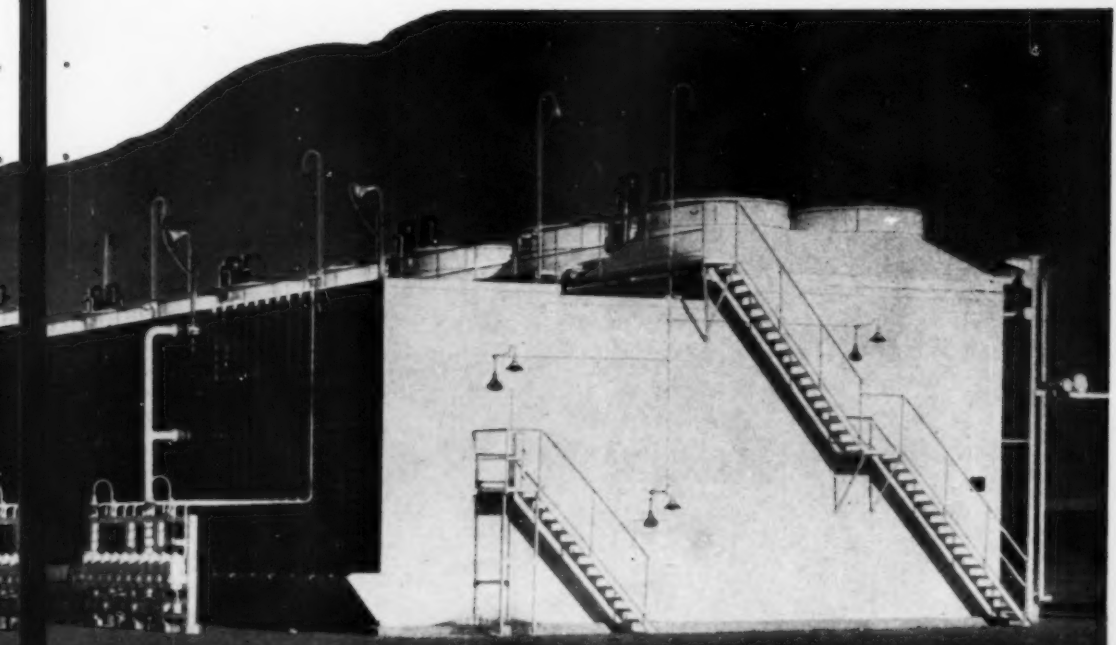
In the COMBIN-AIRE the use of air for cooling is extended to include low temperature cooling services previously necessitating water cooling because of high ambient air temperature. The COMBIN-AIRE allows the use of air-cooling for total heat dissipation in all services.

The COMBIN-AIRE is a combination of a HUDSON water cooling tower with HUDSON air-cooled exchangers housed in one integrated structure. During periods of high ambient temperature the inlet air is first drawn through water at the bottom of the cooling tower, reducing the air to near wet bulb temperature, at which temperature it contacts the air-cooled exchangers. During periods of low ambient temperature the inlet air is used directly in the air-cooled exchangers and no water is evaported in the cooling tower.

When water in good quantity and quality is not available the COMBIN-AIRE has manifest advantages over any alternative combinaton of cooling equipment.

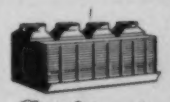
Even when ample water is available and water treatment costs are low, comprehensive comparisons will frequently indicate overall advantages of the COMBIN-AIRE system.

*** The COMBIN-AIRE unit is protected by United States patents**



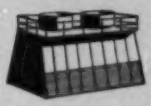
This COMBIN-AIRE unit operated by the Hyperion Oil Company in their Kennedy plant at West Texas discharges heat from all absorption and fractionating plant streams, a total heat load of about 70 million B.T.U. per hour.

Combin-aire DOES WORK OF THREE COOLING UNITS



Combin-aire

COOLING TOWER



AIR COOLED CONDENSERS AND COOLERS

WATER COOLED CONDENSERS AND COOLERS

Combin-aire ADVANTAGES

- **LOW WATER CONSUMPTION.** No water is used during cold weather.
- **NO TREATMENT NECESSARY** for cooling tower water.
- **NO WATER LOSS** as spray or mechanical carryover.
- **NO CONDENSATION** from effluent air.
- **MINIMUM PIPING.** COMBIN-AIRE may be installed immediately adjacent to other process equipment. Use of tubular water cooled equipment for final coolers unnecessary.
- **CLEAN AIR TO AIR-COOLED UNITS.** During hot season air is water-washed removing dust, sand and insects.

In addition to COMBIN-AIRE units, HUDSON manufactures water cooling towers, air-cooled and water-cooled coolers and condensers, and is experienced in plant layout, piping, and water treatment. We shall be glad to assist pospective plant owners in making overall comparisons of first costs and operating costs for complete cooling systems using various plant layouts and combinations of equipment.

HUDSON

ENGINEERING CORPORATION

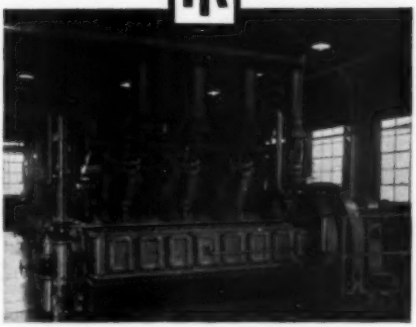
FAIRVIEW STATION • HOUSTON, TEXAS

INGERSOLL-RAND PUMPS USED IN NATURAL GASOLINE RECOVERY

Magnolia Petroleum Company's Hickok Plant, located near Ulysses, Kansas, is currently processing 120 million cubic feet of natural gas daily. From this gas, 100% of the natural gasoline, 50% of the butane and 17% of the propane are recovered by the absorption process. Residue gas is sold to a pipeline. Oil circulation rate is automatically controlled to maintain minimum heating value of 950 BTU. A well pressure of 300 psi makes plant compression unnecessary at the present time.

All centrifugal pumps used in the plant were supplied by Ingersoll-Rand. The Class BSFL Process pumps in the left foreground of the illustration above handle gasoline at 95°F. Other units handle lean and rich oils and the distilled LPG's butane and propane.

Ingersoll-Rand builds a complete line of dependable pumping equipment for the petroleum and refining industries. For real, long-range economy, call in Ingersoll-Rand on your next pumping problem and take advantage of their many years of practical, field experience.



Three, 8-cylinder I-R Class PVG gas engines provide power for the Hickok Plant. Developing 370 hp, these 4-cycle, V-design units drive 300 kw generators. Two I-R Motorpumps handle the cooling water for the engines.

Ingersoll-Rand

Cameron Pump Division, 11 Broadway, New York 4, N. Y.

709-10

COMPRESSORS AIR AND ELECTRIC TOOLS GAS ENGINES PUMPS TURBO-BLOWERS VACUUM EQUIPMENT

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Heat-Transfer Surface

Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

- **High Efficiency**
- **Long Service Life**
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You are assured of high efficiency in heating or cooling—long service life—low maintenance and service costs, when you specify Aerofin extended-surface heat exchangers.

The reason is obvious: Aerofin makes heat exchangers *exclusively*—offers you the results of unequalled experience, unequalled production facilities, unequalled materials testing and design research—and the guidance of a complete, highly skilled engineering staff, at the plant and in the field.

For the most practical solution to your heat-exchange problem, ASK THE AEROFIN MAN.

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First Aid for Cat Crackers Anywhere

IF YOUR CAT CRACKER DEVELOPS ILLS OR YOU HAVE A TECHNICAL PROBLEM ON CATALYSTS, A FILTROL ENGINEER IS READY TO SERVE YOU ON SHORT NOTICE. IN A RECENT 30-DAY PERIOD OUR ENGINEERS GAVE TECHNICAL FIELD ASSISTANCE AND PERFORMED LABORATORY EVALUATIONS FOR REFINERS OVER A WIDESPREAD AREA THAT INCLUDED EDMONTON, ALBERTA; MONTREAL, QUEBEC; TULSA, HOUSTON, PHILADELPHIA AND LOS ANGELES.

YEARS OF EXPERIENCE IN PRODUCING CRACKING CATALYSTS AND OBSERVANCE OF VARIED CRACKING OPERATIONS FORM A BACKGROUND FOR FILTROL'S TECHNICAL SERVICE AND ASSISTANCE IN THIS FIELD. WRITE FOR PARTICULARS.

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FILTROL CATALYSTS

1. HIGHER OCTANE BARRELS
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9. LOW ATTRITION RATE

FILTROL CORPORATION

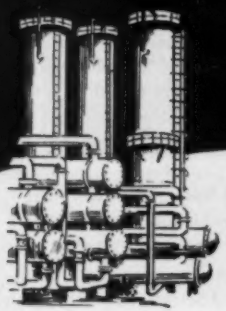
OFFICES: 727 WEST SEVENTH ST., LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

Filtrol*

CATALYSTS AND ADSORBENTS

*T.M. REG. U.S. PAT. OFF

PRECISION PRODUCED FOR PRESSURE PRODUCTION



Pressure Vessels
Forgings and Rings
Hardened and Ground Steel Rolls
Corrosion and Heat Resisting Castings
Ordnance and Armor

MIDVALE PRESSURE VESSELS MEET AND EXCEED MOST RIGID SPECIFICATIONS

From the melting of the steel to the machining . . . every step of the way is "Midvale precision controlled" in producing pressure vessels for the chemical, refining and process industries.

Whether small vessels to withstand low pressures, or one of the largest forged steel pressure vessels ever made as shown in the lathe above—five feet in diameter and made to stand pressures of 9,000 pounds per square inch—Midvale makes them all. Whatever your specifications you'll find Midvale's skilled craftsmen with their modern facilities and years of experience can build to your design or your specification one piece hollow forged bodies of carbon alloy or stainless steel.

If it's pressure vessels for the chemical or petroleum industries . . . roll shells for the mining and cement industry . . . rings for turbines and gears . . . rolls for the paper industry . . . or castings and forgings for any industry Midvale can precision make them to your specifications.

THE MIDVALE COMPANY
NICETOWN, PHILADELPHIA, PENNA.
OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO

MIDVALE
Custom Steel Makers to Industry
PRODUCERS OF FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS

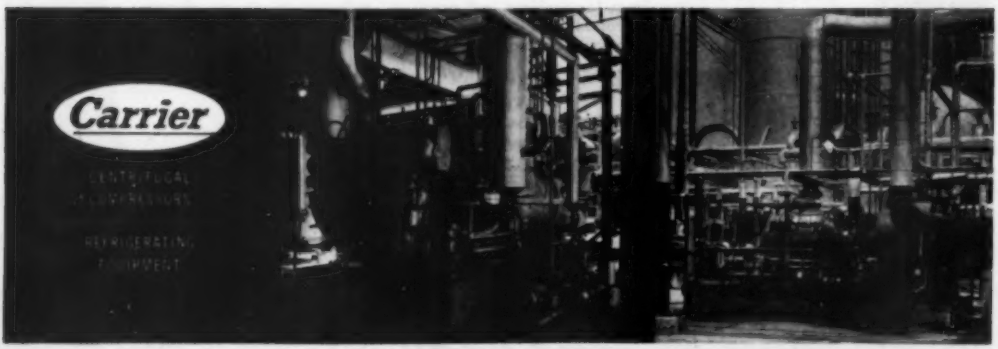
What makes them all go for one?

You know that all over the country alkylation units are being built or reactivated to supply higher octane gasolines for both defense and civilian needs. But did you know that just about every one of them uses the Carrier Centrifugal Compressor?

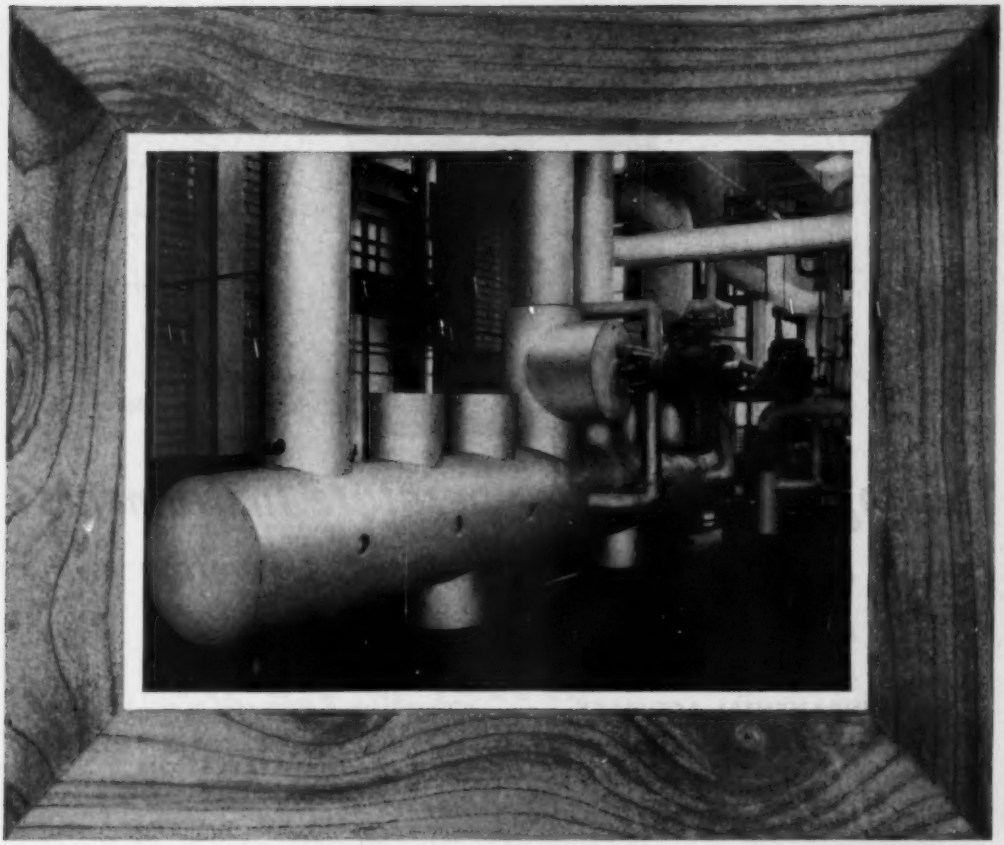
Why this amazing record? Well, first, there's no need for complex control equipment when you use the Carrier Centrifugal – it maintains exact temperature and pressure levels without them. Then, too, in case acids should ever escape, the Carrier Centrifugal Compressor – and only the Carrier – gives you the extra protection of lead-coated wheels.

But we think one single important word tells the main reason for the Carrier Centrifugal's popularity. *Experience.* Experience for more than thirty years, building more multi-stage centrifugal compressors than anyone else in the business. That kind of experience is worth taking advantage of, don't you agree?

We'd like you to have our catalog, "Centrifugal Compressors for Industry." Ask for it at the nearest Carrier office, or write Carrier Corporation, Syracuse, New York.



Both the hydrofluoric acid alkylation unit at Sinclair Refining's Corpus Christi plant (left) and Mid-Continent Petroleum's sulphuric acid alkylation unit in Tulsa use Carrier 350 series Compressors. Carrier Centrifugal Compressors are built in standard designs from 2000 to 40,000 cfm., with three to seven wheels.



Insulation Contractor: Guy M. Beaty & Co., Charlotte, N.C.

Steam header at Cannon Mills Co., Kannapolis, N.C., insulated with K&M Hy-Temp and "Featherweight" 85% Magnesia Combination, finished with sewed canvas jacket.

PORTRAIT OF STEAM HEADER AT 750° F.

clothed for life . . . . with K&M Insulations

YOU SEE here one of the most efficient combinations you can get today for lifetime protection against heat loss—K&M Hy-Temp Insulation teamed up with "Featherweight" 85% Magnesia.

You can use the same combination, in appropriate thicknesses, for efficient insulation of temperatures from 600° F. up to 1900° F.

K&M Hy-Temp Insulation is applied directly to the high temperature surface in sufficient thickness to lower the temperature of the outer surface of the insulation to 600° F. or less. "Featherweight" 85% Magnesia, which has a higher insulating value, is then applied directly over the Hy-Temp Insulation, thus utilizing the advantages of both insulations to the fullest extent.

These insulations are supplied in appropriate forms and thicknesses for application to equipment surfaces and piping.

Your local K&M distributor, who is an experienced applicator, will give you full information. Or write us direct . . . we'll rush a reply.

Nature made Asbestos . . .

Keasbey & Mattison has made it serve mankind since 1873

KEASBEY & MATTISON

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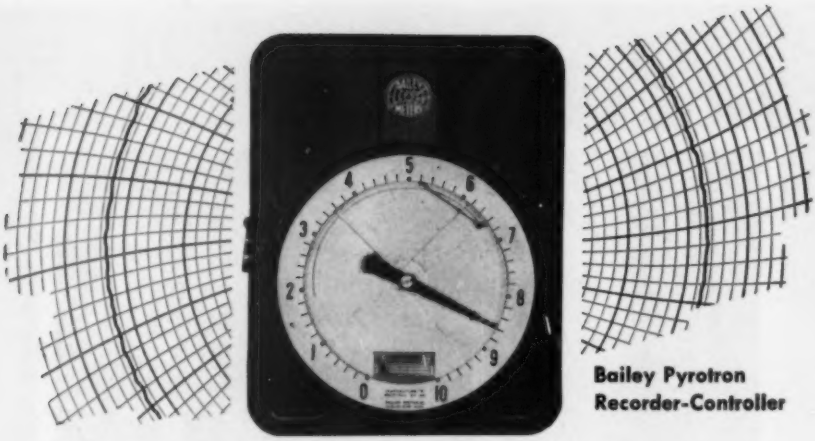


Bailey Pyrotron
Recorder-Controller

Looking for Better Temperature Instruments?

. . . Then check these features of Pyrotron Electronic Resistance Thermometers . . .

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

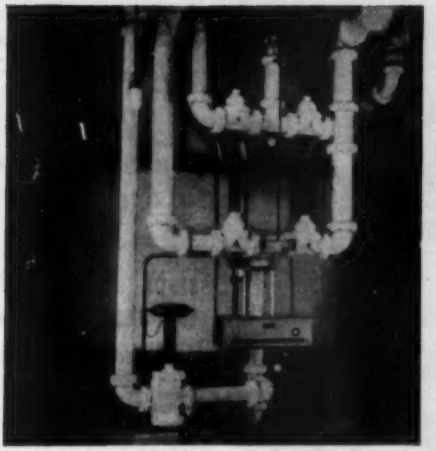
For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

1043 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO



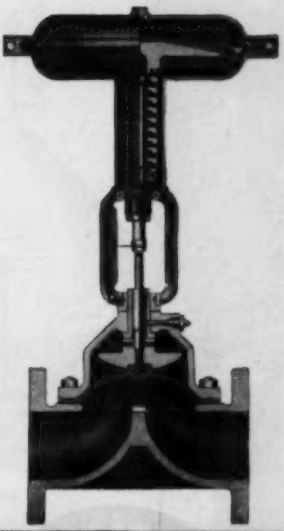
HOW K & M VALVES HELP "SOFTEN UP" 120,000 GALLONS OF HARD WATER PER HOUR

The mineral salts in hard water can cause extremely costly damage to the boilers of a power plant.

At one of America's most important industrial plants, a massive installation of cation and anion exchangers "softens up" or demineralizes water at the rate of 120,000 gallons per hour, thus protecting the steam generators.

The big exchanger units are complicated and require trustworthy regulation of flow at many points. 125 K & M Saunders-Type valves in the assembly do the job with safety, certainty and precision. Moreover, the installation has been so successful that the company is building a similar one, for which K & M valves are also being used.

Leaders in many industries look to K & M valves for proved sensitivity and endurance. K & M is geared to handle the smallest or largest problem in control valves, however exacting the requirements. Our engineers invite your inquiries.



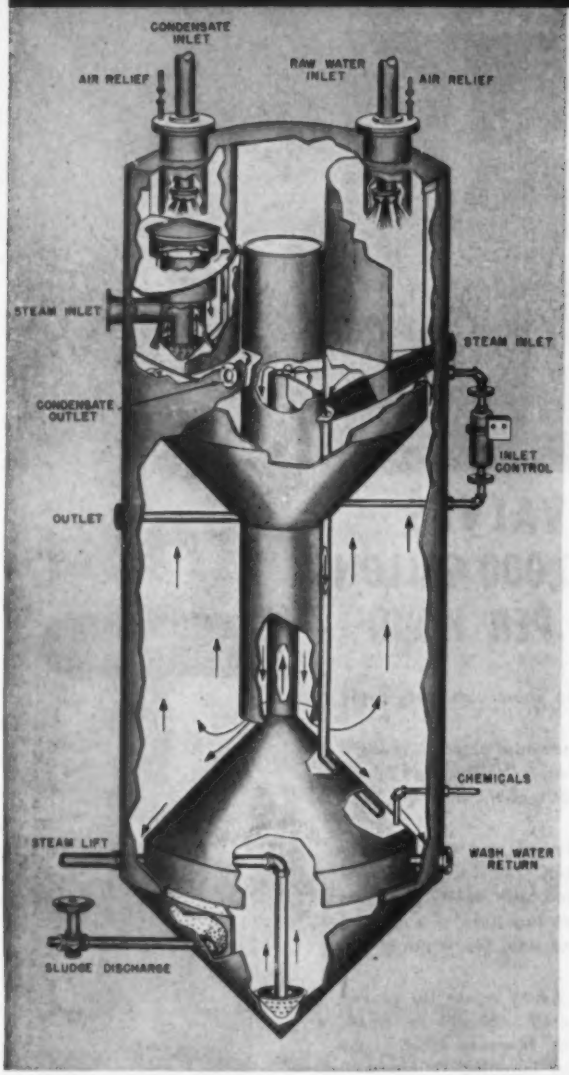
K&M

KIELEY & MUELLER, INC.

Valve Makers Since 1879

2033 - 43rd STREET NORTH BERGEN, N. J.

The Hot Process ACCELATOR®



MULTI-PASS TREATMENT FOR

- ***Softening***
- ***Silica Reduction***
- ***Deaeration of Makeup and Condensate***

☆

HERE'S THE ANSWER TO 3 OF THE POWER ENGINEER'S MOST COMMON PROBLEMS

SOFTENING: Positive internal slurry recirculation insures maximum softening, alkalinity reduction, and turbidity removal with a minimum of chemical expenditure. A steam lift effects the recirculation thereby eliminating mechanical pumping devices. A storage compartment within the tank holds sufficient treated water to handle momentary peak demands.

SILICA REDUCTION: Prolonged contact of the water undergoing treatment with the recirculating slurry as well as the redissolving of magnesium in the slurry, reduce silica to a new low.

DEAERATION: The steam lift effectively deaerates the makeup water undergoing treatment, thereby eliminating the need for separate deaerating mechanisms. The condensate enters a separate chamber in the upper portion of the tank and is recycled and scrubbed by its own steam lift system.

FOR THE COMPLETE STORY on how these results are accomplished, as well as a complete and informative discussion on boiler feed water treatment, write now for **BULLETIN 1855**

INFILCO

* BETTER WATER CONDITIONING * AND WASTE TREATMENT SINCE 1914

INFILCO INC. *Tucson, Arizona* | *Plants in Chicago & Joliet, Illinois*

FIELD ENGINEERING OFFICES IN 26 PRINCIPAL CITIES

World's Leading Manufacturers of Water Conditioning and Waste Treating Equipment

TNEMEC PRIMERS KILL RUST!

SMALL amounts of moisture will inevitably penetrate any paint film, causing rust and corrosion . . . but TNEMEC *uses* this moisture to destroy rust at its source!

TNEMEC PIGMENT is a compound which includes and intensifies the preservative properties of Portland cement. Combined with moisture, it creates a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

That's the amazingly simple process that makes TNEMEC so outstandingly successful as a prime coat on steel. We invite you to investigate the performance of TNEMEC Primers on any type of installation . . . for adhesion, waterproofness and durability . . . under the most severe conditions. Its record as a long-lasting, anti-corrosive coating is unique.

Ask Any TNEMEC User
(TEE-NEE-MIK)

MAIL THIS COUPON FOR YOUR COPY OF TNEMEC CATALOG 50

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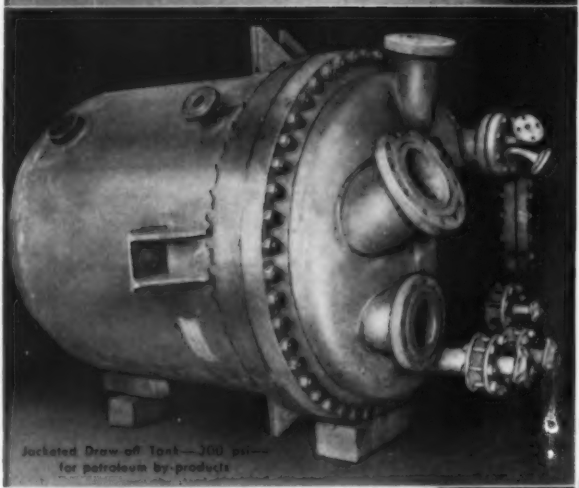
It's GRAVER for pressure vessels and code work!

Two Quench Pots 3' x 21' 6"—35 psi—
for petrochemicals



Jacketed Draw-off Tank—300 psi—
for petroleum by-products

Processing plants today increasingly require specially designed pressure vessels. Graver has long been expert in the fabrication of code vessels, whether API-ASME, ASME or even more stringent specifications set by customers. Graver-built pressure equipment assures long life and safe, dependable service.

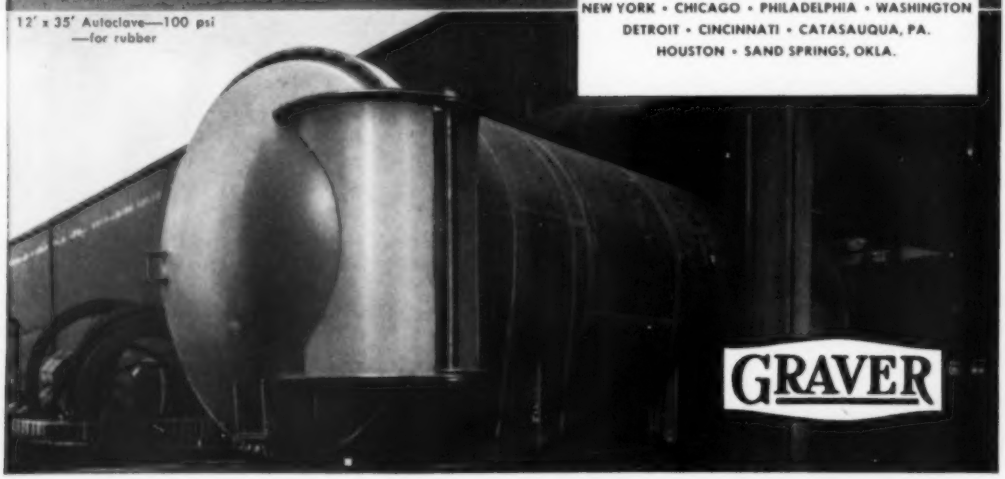
The steady flow of steel, clad and alloy pressure vessels through Graver's plants is suggested by these shop views. They indicate the many skills and services obtainable through Graver's high standards of welding craftsmanship.

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • CHICAGO • PHILADELPHIA • WASHINGTON
DETROIT • CINCINNATI • CATASAUQUA, PA.
HOUSTON • SAND SPRINGS, OKLA.

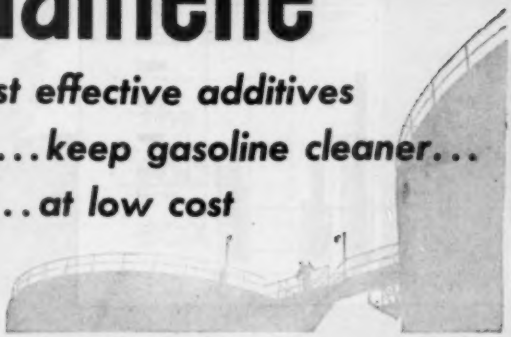
12' x 35' Autoclave—100 psi
—for rubber



GRAVER

Tenamene

the most effective additives known... keep gasoline cleaner... longer... at low cost



WHAT IS GUM? Gum is a non-volatile material resembling varnish or lacquer. Soluble in gasoline, gum separates only when gasoline evaporates, unless highly concentrated. Sometimes gum settles as a heavy, dark-brown oil. The enemy of engine efficiency, gum coats carburetors, plugs jets and screens, and causes valves to stick.

WHAT INHIBITORS DO. Commercial gasoline inhibitors retard oxidative deterioration, the first step in gum formation. To prevent storage loss, inhibitors should be soluble in gasoline but not in water. They should not color gasoline and should resist darkening.

THE TENAMENES — EASTMAN INHIBITORS. For years Eastman has made the most effective gum inhibitors known—Tenamene 1 and Tenamene 2. Formerly these were sold through another company under another name. Now Eastman makes them available directly and from convenient stocks. Choice between the two gum inhibitors depends on a number of factors, such as the crude, the treatment and possible caustic carryover. Tenamene 2 should be used where traces of caustic are present. Where caustic is not present, choice must be based on such tests as ASTM Gum, Oxygen Bomb or Copper-dish Gum. Since Tenamene 2 is more concentrated and non-inflammable, its slightly higher cost is frequently more than offset by lower shipping costs.

FOR MOTOR FUELS. Tenamene 1 is a mobile, tan liquid composed of 48% N-n-butyl p-aminophenol in isopropanol. 5 to 52 lbs. per 1000 bbls. inhibit gum in most motor fuels, protect dyes from fading, and retard tetraethyl lead decomposition.

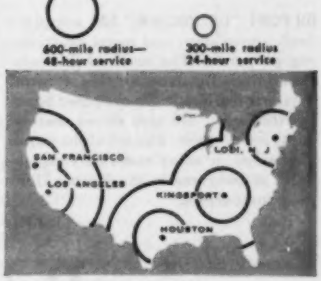
FOR MOTOR FUELS AND ALL AVIATION GASOLINES. Tenamene 2 is a mobile tan-to-red liquid comprising N,N'-di-sec-butyl p-phenylenediamine. For motor fuels generally, 2.6 to 26 lbs. per 1000 bbls. are used. Tenamene 2 has been thoroughly tested in aviation gasolines and approved for military purposes. It is highly resistant to extraction by water and caustic solutions. In hot, humid climates Tenamene 2 greatly retards deterioration of aviation gasoline that results in lead deposits. The maximum concentration allowable in aviation gasolines (8.4 lbs. per 1000 bbls.) should be added.

FOR COPPER CONTAMINATION. Tenamene 60, third member of the Tenamenes, is a mobile, red liquid composed of 80% disalicylal propylene di-imine in toluene. Traces of copper are often found in gasoline—from treating processes or from copper equipment employed during production, storage or use. Tenamene 60 overcomes the catalytic effect of copper on the oxidation stability of gasoline.

TESTS PROVE TENAMENE EFFECTIVE. Various tests with all types of gasoline proved the effectiveness of the Tenamenes. Uninhibited gasoline deteriorated rapidly in storage, forming considerable gum. Tenamene stabilized gasoline formed little gum in prolonged storage. Tennessee Eastman will be glad to make these analyses on any refiner's gasoline.

HOW TO USE TENAMENE. In general, unrefined cracked gasoline should be treated with Tenamene promptly after condensation. Refined gasoline should be treated as it is pumped to storage. If delay is necessary, add small amounts initially, the balance later. Tenamenes can be added in concentration, but are better added as dilute stock solutions since small quantities are generally involved. Common procedures are the proportioning pump, eductor or gas-pressure method. Tenamene 1 and 2 should be protected from air to prevent discoloration. Tenamene 60, however, does not need inert atmosphere for application.

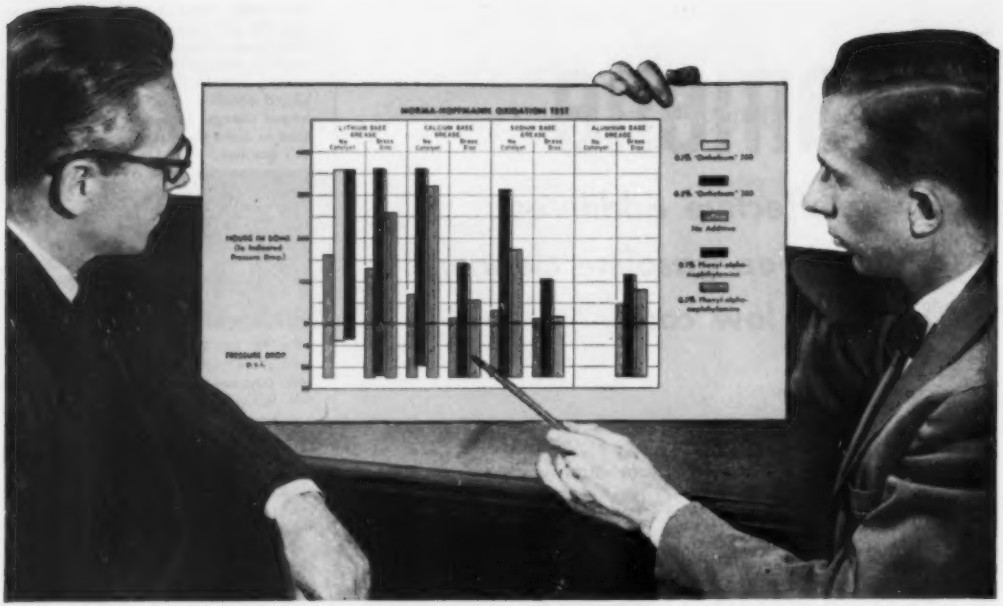
WHERE CAN YOU GET TENAMENE? Eastman can give top service on your requirements of these excellent additives. Stocks of Tenamene are carried at five convenient locations. A glance at the map below shows delivery schedules. Write to one of our sales representatives* or to Kingsport, Tennessee for prices, specifications, and other information.



Tenamene EASTMAN GASOLINE ADDITIVES

TENNESSEE EASTMAN COMPANY, *Division of Eastman Kodak Company, Kingsport, Tennessee*

***SALES REPRESENTATIVES:** New York—10 E. 40 St.; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; Houston—412 Main St. WEST COAST: Wilson Meyer Co., San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.*



YOUR CHOICE OF TWO DU PONT ADDITIVES FOR LOW-COST GREASE STABILIZATION

The demand for greater stability in greases is constantly increasing. This is due to the higher operating speeds and temperatures of modern equipment. To help you meet these conditions, and to increase the stability of your greases economically, Du Pont offers "Ortholeum" 300 and Phenyl-alpha-naphthylamine.

DU PONT "ORTHOLEUM" 300 supplies both antioxidant and metal deactivating properties. The result of this combination is outstanding where metal catalysis is a factor. On the other hand, "Ortholeum" 300 also shows marked superiority over Phenyl-alpha-naphthylamine in many non-catalyzed systems, as indicated in the Norma Hoffman comparison.

In many greases "Ortholeum" 300 provides high resistance to color deterioration, even under long exposure to light. It can either be added directly, or in an oil concentrate just prior to the final cooling period. For normal requirements, the treating cost of grease is under ½¢ per pound.

DU PONT PHENYL-ALPHA-NAPHTHYLAMINE gives excellent results in most non-catalyzed systems when the superior color stability of "Ortholeum" 300 is not essential. In equal concentrations, its lower price per pound means lower treating costs, too.

Since greases vary widely in their composition, their response to different stabilizers varies also, and the degree of stabilization required for different applications varies as well. Under the circumstances it will pay you to evaluate each of these two Du Pont additives in all of your greases—on the basis of quality as well as economy.

SAMPLES of "Ortholeum" 300 and Phenyl-alpha-naphthylamine are yours for the asking. Simply contact your Petroleum Chemicals Representative, or address your request to the Du Pont District Office nearest you.

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Better Things for Better Living
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PETROLEUM REFINER

The LOOK BOX

It's A Special This Month

THIS ISSUE of PETROLEUM REFINER places special emphasis on natural gasoline and the light hydrocarbons, and contains a special section devoted exclusively to articles on this important phase of the refining industry. The natural gasoline and LPG industry is viewed by many as the fastest-growing segment of the petroleum industry. The 1951 production of natural gasoline and LPG was 205,000,000 barrels, representing an average production of 563,000 barrels daily. This was 13.2 percent more than the corresponding production of 1950. The 1952 production is forecast at 217,000,000 barrels, which is more than double the production achieved in 1944.

Sales of LPG alone reached 4100 million gallons in 1951, and LPG now ranks as one of the major suppliers of energy in the country. In addition, LPG has become a major source of raw materials in the fast-growing petrochemical industry.

Last year saw the start-up of the largest natural gasoline installation in the world. This is the Snyder gasoline plant, owned by a group of 30 companies and 60 individuals. Beginning on page 119, W. F. Chapin presents the first complete engineering description of this important plant.

The heart of any natural gasoline plant is the process used. There are a number of basically different processing schemes available, and the selection of the optimum recovery process depends on many factors. Starting on page 137, T. H. Anderson, Jr., and W. E. Colburn review the whole problem of gasoline process selection. Of prime importance in the design of the recovery process is the composition of the charge stream. Important new insight to the composition of natural gasolines is provided by V. R. Ratzlow and A. A. Ruoho in a feature article beginning on page 125. These investigators set a new high in thoroughness by identifying and measuring more than 40 individual hydrocarbons in two West Texas natural gasolines.

One of the most powerful tools in the design of light hydrocarbon processing schemes is the science of thermodynamics. D. F. Othmer and R. D. Beattie, beginning on page 129, present a new method for correlating the entropies and enthalpies of pure and mixed hydrocarbons and other gases.

Perhaps the most important pieces of equipment in a natural gasoline plant are the compressors. Frequently overlooked in the selection of compressor cylinders is sufficient operating flexibility and adequate provision for future expansion. R. S. Ridgway thoroughly covers this important subject in a two-part series beginning on page 166.

Of the great variety of operating problems encountered in natural gasoline plants, one of the most troublesome is that of water treating. This subject has not been given the attention it properly deserves. Starting on page 142, M. C. Forbes presents a complete case history of how tough water control problems were solved at a typical natural gasoline plant.

These, and many other important articles pertaining to natural gasoline and the light hydrocarbons are included in the special section beginning on page 119.

The Biggest LPG Problem—Storage

NEXT TO TELEVISION, the LPG industry is the fastest growing industry in the country. Faced with promoting a relatively new product, the National Committee for LPG promotion has recently completed a study of LPG storage which points to the importance of adequate storage at all levels—consumer, distributor and producer—as the solution of the unbalanced winter load problem.

The major objectives for the industry-wide project have been tabulated as follows:

1) Permit a 1:1 ratio of winter vs. summer de-

Top-of-Page Photo—The distillation unit at Shell Oil Company's new Stanlow refinery in England shown at night. The refinery has been in operation approximately one year.

TAKE
A
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LOOK

at

OXIDATION

Oxidation is one of the simplest yet most frequently-encountered forms of corrosion affecting the service life of steel tubes in high-temperature applications. When tubes are exposed to elevated temperatures for extended periods of time, scale will form of sufficient thickness to flake off, causing progressive loss of metal. Resistance to oxidation, or scaling, is therefore an important consideration in determining the suitability of tubes for severe temperature conditions.

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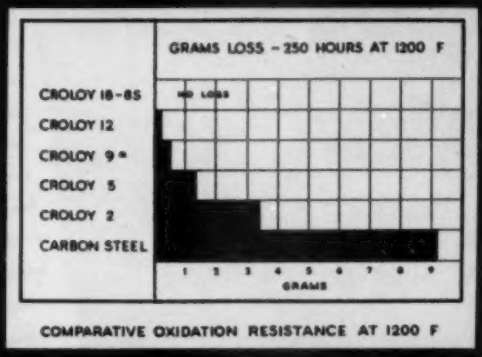
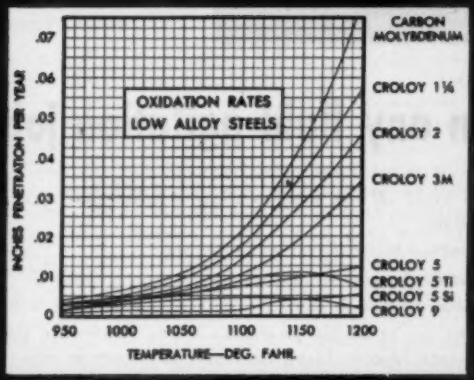
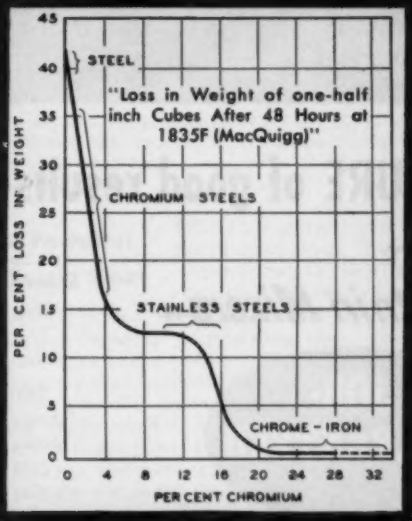


COMPARATIVE OXIDATION RESISTANCE AT 1200 F





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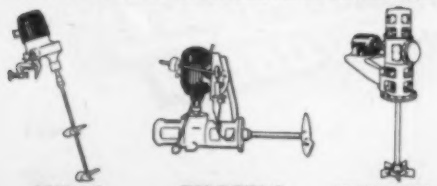

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liveries of liquefied petroleum gas.

2) Protect consumers against shortages during peak use periods.

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The importance of the storage problem has prompted PAD to send out questionnaires to about 13,000 producers, marketers, distributors and dealers to determine what storage facilities are available. According to PAD, the nation is in a position where sudden developments in defense needs could place a heavy burden on the industry.

Superflous and Costly

THE NATIONAL Petroleum Council committee on synthetics fuels, it would appear from our viewpoint, has made a pretty strong case against government's effort to produce synthetic liquid fuels from coal.

But even though this committee, comprising top-flight men of the industry, has pointed out the many fallacies in the Interior Department's scheme, it is most unlikely that Washington will take heed. The huge funds needed to pursue this project will be lumped with the nation's military needs and taxpayers one of these days will be forced to swallow the king-size pill.

"Fantastic and out of the question" and "just another way to throw money away" are two of the tags hung on the Interior's scheme by the NPC committee chairman, W. S. S. Rodgers, whose report differs from the Bureau of Mine's cost analysis on four major points:

1) NPC's estimate of investment costs is $121.5 million more.

2) NPC's estimates for annual operating labor and maintenance costs are $10.7 million greater.

3) The proposed plant would have chemicals accounting for more than one half of the total revenue and "cannot be classified as a liquid fuels venture."

4) The Bureau's product revenue figures are overstated.

The NPC report is convincing, if any further evidence was needed, that the American taxpayer should not have to shoulder additional burdens by subsidizing a commercial fuels plant when proved crude reserves in this country are in excess of 30 billion barrels.

As The Texas Company's J. W. Foley said in a recent talk, ever since petroleum became a major source of power many authorities, including government officials have been prophesying early exhaustion of the country's oil resources.

And yet despite production of 20.7 billion barrels of oil since 1939, proven reserves today are 11.5 billion barrels greater than they were then.

"Advocates for government assistance in building synthetic fuel plants realize that such fuel cannot compete with petroleum and are now proposing that a plant be built in the interest of national defense," Foley charged.

This contention falls from lack of force when it is realized that "in the event of a national emergency, oil production could be increased and, with a moderate rationing program, an additional amount of liquid fuels in excess of all of Russia's current production could be diverted to our military forces."

As long as our crude oil reserves are adequate —and experience indicates that they will show gains for many years if the government doesn't stifle exploration with unwise legislation—as long, we repeat, as the oil industry is alert in building up reserves, then so long will opposition be voiced in these columns against government subsidy for construction of synthetic fuel plants. It's one thing for an individual or a company to bet its own money on the success of a synthetic liquid fuel plant, but it's quite another for the government to advance tax money to subsidize a superfluous scheme that has no chance in the present competitive setup.

A Powerful Young Giant

THE U. S. natural gasoline industry more than doubled its output during the short span of years since the end of hostilities of World War II, and continues to build for further expansion of producing rates. Texas, the leading natural gasoline producer, now accounts for more than one-half of the nation's output, and alone produces more than the entire country did at the war's close. At present, there are at least a dozen plants being constructed or planned in Texas, and more are sure to come.

As the war ended there were slightly more than 200 Texas plants engaged in removal of liquid hydrocarbons from the natural gas that had been proved so bountiful in the state. Today, these plants number about 350, and they each average about 1000 barrels of natural gasoline and allied products per day, to boost Texas far out in front of the other producing states. It is a position that hardly appears in danger of ever being challenged.

Laws in the interest of resource conservation are perhaps the most forceful stimulus to natural gasoline facility construction in Texas, and the giant pipe lines leading out in almost every direction make the projects possible. Natural gas produced incident to crude production had to be utilized after the state's regulatory body clamped down on flaring of casinghead gas. With the post-war construction of large gas transmission lines came a market for the residue gas that remains after liquid hydrocarbon removal.

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PETRO-CHEMICALS	Production and refining of ethylene, ethylene oxide, ethylene glycol, ethanol, and other ethylene derivatives; isopropanol and methyl-ethyl ketone; butadiene, benzene, heptane, toluene, styrene, diphenyl; and chlorinated hydrocarbons such as chloroethane, chlorobenzenes, and chlorotoluenes.
PHARMACEUTICALS	Antibiotic production; fermentation pilot plants; recovery units for solvents utilized in antibiotic purification; and special production and separation processes for biochemical operations.
LOW TEMPERATURE GAS SEPARATION	Complete units for separation of low and high purity oxygen from air; hydrocarbon separations; low temperature vessels for storage and transportation of gases.
WASTE DISPOSAL	Concentration and combustion of aqueous organic chemical waste liquors, particularly liquors containing carbohydrate and lignoous components; with provision for heat and power recovery where economically feasible.
CHEMICAL RECOVERY	Absorption, extraction, and distillation processes for organic solvent recovery; sulfur dioxide recovery from sulfite pulp mill waste liquors and stack gases; and organic vapor recovery from vent gases.
EXTRACTION AND DIFFUSION OPERATIONS	Liquid-liquid extraction processes for recovery and purification of liquid and solid organic chemicals; the Vulcan-Kennedy liquid-solid extraction process for oil-seed processing, soluble coffee production; fiber washing and other specialized countercurrent diffusional operations.

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The Role of Cost Accounting In Refinery Operating Control

EMORY M. SKINNER

Socony-Vacuum Oil Company, Inc., Augusta, Kansas

MUCH HAS been said in recent years regarding refinery cost control. In industry-wide meetings as well as in individual company council many informative discussions have been conducted. Too often, however, we permit ourselves to hurriedly define Cost Control as the mechanism for reducing operating costs. Such a brief definition is not sufficient. The cost of an operation becomes significant only when related to accomplishment. It is the reduction of costs in order to accomplish a given end result that represents effective cost control.

FROM the viewpoint of society, the management of our oil refineries must be looked upon as a position of trust. Accomplishing maximum efficiency in converting this important natural resource to the products needed by society is an obligation. The elements of sound business, including the interest of the workmen, the interest of the stockholders and the preservation of the plant, are not sufficient. Any waste in the form of excess manpower, of excess materials consumed, or the production of inferior or little needed products constitute an economic waste.

The interests of society are safeguarded through the vigorous efforts of individual enterprise in this highly competitive business which force a high degree of efficiency to insure survival. It is in our search for an accurate measure of this efficiency that we become conscious of cost control.

Effective cost control can be realized only through properly formulated economic studies and analyses of authentic cost records.

In contrast to other manufacturing operations where material, labor and other expenses may be computed for each product or job as a continuous process cost, or a by-product operation in which the production of a major product is accompanied by the production of one or more minor products, petroleum refining falls into the type referred to as a joint manufacturing operation in which no one of the many products recovered from a common source of raw material can be considered as a major product. The students of cost accounting have developed various methods of determining individual product costs in a joint product operation including methods of average unit costs, the allocation of joint costs on the physical unit basis, and the allocation of joint costs on the basis of selling prices. While such procedures may have limited value in general corporate accounting, it is generally agreed that none of these methods is completely satisfactory. In order to study the efficiency of a joint product operation and exercise effective cost control, our cost analyses must include other concepts.

The most significant figure representing the refinery operation is the value of the over-all result recognizing the applicable imput cost, total operating expenses, and total product value. In most cases, any attempt to evaluate independently the finite accomplishment of an intermediate step or process within the refinery will lead to an approximation only which may be definitely misleading. To establish only expense items is not sufficient; the accomplishment must also be evaluated. The value of the accomplishment or an intermediate refining step involves the pricing of intermediate or unfinished stocks, some of which may have no established commercial value.

Any developed value of such stocks is an approximation and may make the entire evaluation unreliable. Likewise certain expense items, such as the cost of steam, varies with the total quantity used and this total cost change must not be reflected upon only the single process in question.

Substantially all problems of refinery economics or cost control fall into one of these classifications:

1) The construction of an entirely new facility, or the addition to or replacement of equipment at an existing plant.
2) A change in through-put or processing procedures, or the manufacture of a new product with existing facilities.
3) The study of the cost of specific activities such as a maintenance procedure of certain operating manipulation.

The procedures used for evaluation and as a basis for the justification of new or additional facilities are quite uniform. In all cases the earning position of the existing plant is compared with that calculated for the revised plant and the gain in realization must amortize the new facilities. We will not dwell further upon this phase of the problem other than to point out certain elements of detail which are common to the solution of other problems.

In general, the study of the costs of specific activities or manipulations embody the elements of established cost accounting procedures. The degree to which the costs of such specific manipulations can be determined from the routine accounting record depends upon the detail in which such data are recorded. Frequently we cannot justify everyday routine accounting to this extent. It is best that we supplement the general accounting with the greater detail in specified areas for a limited period of time or set up a program of time or performance study as needed. The most useful implement for this purpose is an accounting system built around a job or work order system.

The most significant class of economic study, but also the most difficult to execute with satisfactory accuracy, is the broad problem of investigating various processing procedures. Examples of this class of problem are:

1) Changes in the amount of crude processed which, due to limitations of certain facilities, forces a different ratio of the various products.
2) The processing of crudes of different characteristics.
3) The production of a different complement of products from a fixed crude run and the same facilities.
4) The effect of operation severity in certain processes such as temperature of recycle ratio in cracking.

These, as well as many other prob-

This presentation, at the 40th Annual Convention of the Western Petroleum Refiners Association in San Antonio, April 2, 1952, was made by R. R. Irwin of Socony-Vacuum in place of Mr. Skinner, whose untimely death came as a shock to his many friends in the refining industry.

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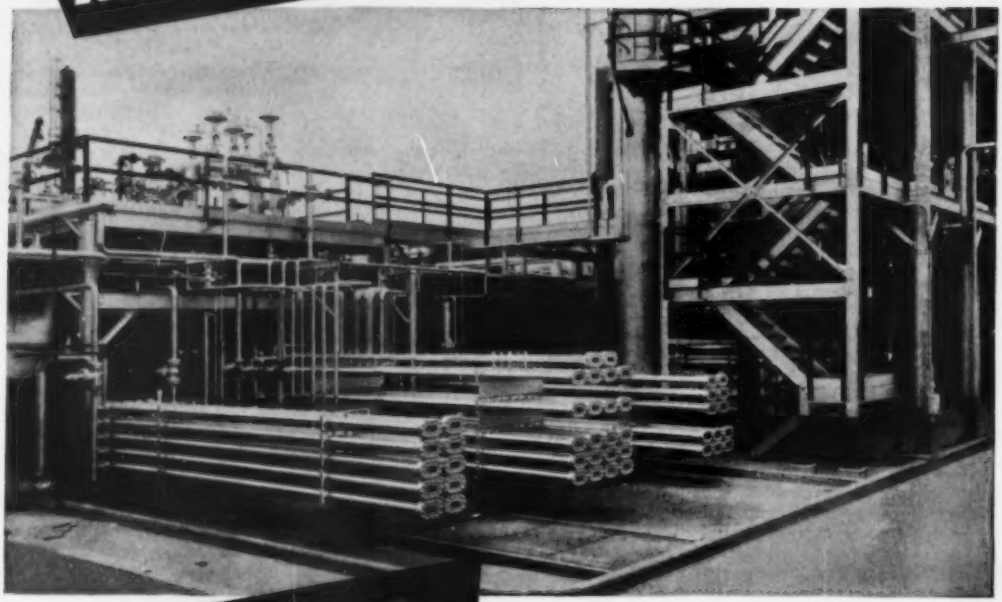

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lems, cannot be localized to permit evaluation within the confines of one processing unit. Several processes, possibly the entire plant operation, are usually affected to some extent, and in many cases the magnitude of the effect is quite obscure. Particular attention must be given to utilities such as steam. The cost of steam is not independent of the amount produced since both the fixed and variable elements in the cost of steam are of considerable magnitude. The unit cost of steam is different for each total quantity produced. Likewise, throughout the entire operation there are expense items which are fixed regardless of the operation, expense items which are a function of stream days, expense items which vary directly with the amount of oil processed, and other expense items which change by specific increments.

For problems involving these far-reaching interrelationships, the most reliable answer will be obtained by evaluating step-wise the entire plant operation. The significant steps in an evaluation of this type are:

1) Starting with the crude oil and any other imput materials, tabulate a material balance showing the quantity of products produced from each processing step, and carried out to the desired complement of finished products. In heavy oil processes such as vacuum distillation, most lubricating oil processes and many redistillation steps, a volume balance is sufficient. In any process which results in a change of chemical composition or physical state such as cracking, vapor recovery and alkylation, a weight balance must be developed. Yield data for the various processes may be developed from plant measurements, specific test run procedures or laboratory determinations. Unit process operations should be calculated on a no-loss basis, with normal handling losses reflected only in finished products.
2) Establish the required operating schedule for each process including turn-around time, the method of operating units which may not be fully loaded and any blocked operations which may be required.
3) Develop realistic expenses for each operation compatible with the required mode of operation. All labor expense and associated charges should be made to the department where that labor normally functions. Material and operating supplies should be listed where used. Utilities and similar services should be accumulated in quantity and the expenses developed at the point of production. A complete maintenance schedule should be developed and priced. In order to avoid overlooking some expense item that is not obvious, all service and overhead items should be tabulated at their normal or established cost.
4) Develop the imput cost of production value by pricing all petroleum commodities at the current plant price.
5) From these elements of expense and realization, a statistical profit can be determined.
6) Make this evaluation for the normal plant operation or base case, and for any modified operation that is under consideration. The difference in profitability of the two cases must be reflected upon the modification under study.

This approach to the solution of these problems may appear to be a prodigious task. That impression will be substantiated if proper preparations are not made. In fact, without benefit of a systematic procedure and basic data developed through a reliable manufacturing accounting system, the evaluation can become so complex that minor variations in the treatment of certain production and expense items will overshadow the true difference in the process schemes under study. On the other hand, with a fully developed base case for normal operations and a cost accounting system which produces true operating statements, the evaluation of alternate operating procedures can be developed with reasonable accuracy and effort. Likewise, the periodic statements of actual operating results derived through a suitable accounting procedure can be compared directly with this normal or base case to establish a measure of operating efficiency.

In reference to the justification of new facilities, it was indicated that it is common practice to consider the effect of such facilities upon the earning position of the entire plant. Studies for this purpose should be carried out in a manner similar to that which has just been described for studying processing changes.

The Cost Accounting System

A discussion of refinery cost accounting was presented at the regional meeting of the Western Petroleum Refiners Association at Wichita, Kan. on June 10, 1949. Believing that the fundamental concepts then presented are correct, some repetition is unavoidable in any further reference to that activity.

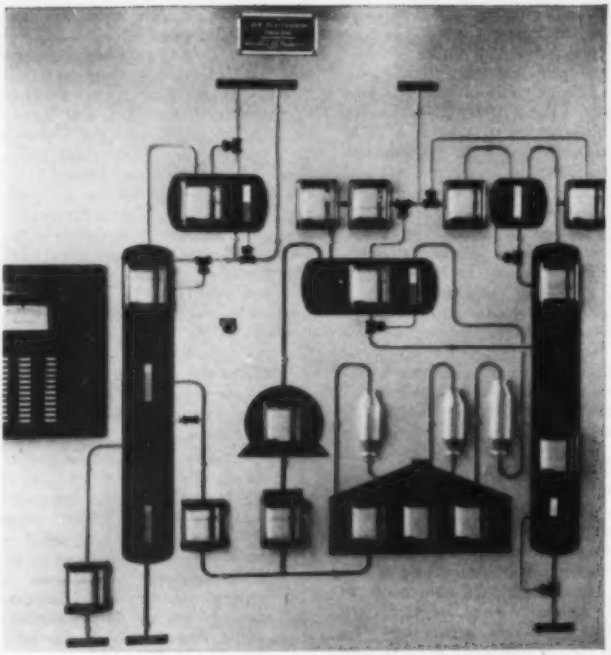
The information obtained through the channels of cost accounting can be one of the most useful tools available to refinery management at all levels for the successful direction of refinery activities. On the other hand, the mere fact that certain data have been assembled through accepted accounting procedures does not insure their usefulness in the control of manufacturing operations.

Before we examine the aspects of cost accounting as may be applied to petroleum refining, let us understand the objectives of any cost accounting. At no time do the results of accounting activities exercise control; control is a matter of executive action, a large part of which may be based upon the data and information made available through cost accounting and analysis. It is important, therefore, that our accounting be based upon the principle of "Accounts for Operators" rather than "Accounts for Accountants." While the basic principles of bookkeeping must be followed, the reports resulting from the system must reflect the operations clearly and accurately. We must first determine the type of data and reports that will be most useful to the operators and then develop the cost methods that will produce them.

Who are the people for whom cost reports are prepared? Broadly three classes of executives and their needs may be recognized:

1) Operating departmental supervisors and foremen, who are in direct charge of the day-to-day activities of the specific plant functions, must have detailed reports which inform them of the costs and accomplishments of current performance. Historical records are of only secondary value. Supervisors at this level are directing activities which will be consummated in the immediate future. They need data which will assist in their judgment of the result to be expected from a specific operational manipulation.
2) Plant superintendents, works managers and heads of staff departments, such as the chief engineer, need reports which present the over-all results of unit operations and of the total plant operation. These reports need to encompass the shortest reliable accounting period consistent with the nature of the operation. Executives at this level are concerned with the coordination of the various units of the plant as required to meet

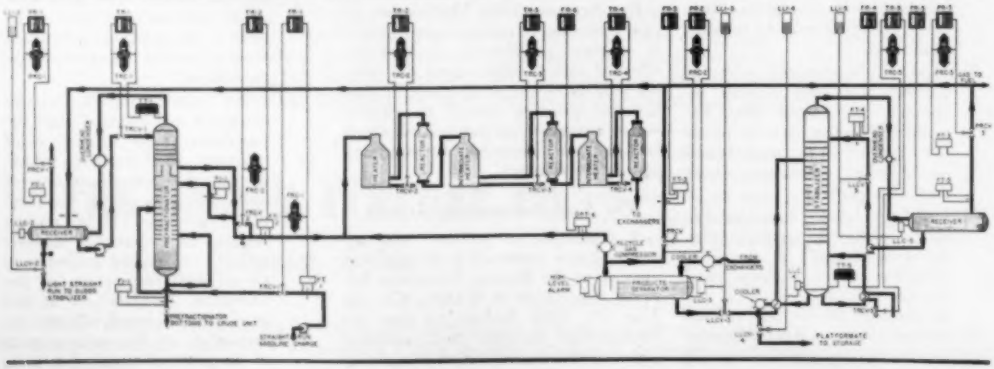
Why did Mid-West PLATFORMING



The Graphic Panel at left, with 16 TRANSET Recorders, also was designed by Universal Oil Products Company, to show all critical variables and control points of the Platforming process at a glance. Operator can check all parts of the process, make any desired changes, right on the board. TRANSET Recorders shown connect to TRI-ACT Controllers on rear of the board, connected in turn to field mounted Taylor Transmitters.

* * *

The drawing below shows the schematic flow diagram and instrumentation of the Platforming process, indicating the wide use of Taylor transmitters, controllers and recorders for maximum efficiency.



Refineries put under TAYLOR TRANSET* CONTROL?

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"With TRANSET Control" says Vice President Everett E. Thompson, "we are having no trouble, for instance, in holding the Platformer transfer temperature at the desired figure. This is important, because of the effect of temperature on octane."

"The Platforming process under TRANSET Control has done an almost unbelievable job; we are able to turn out 90 to 95 octane gasoline, with 90% to 95% liquid yield from straight run," states R. J. Oosdyke, Vice President in Charge of Sales, "and this yield of top quality product puts Mid-West's White Rose gasoline in an extremely favorable competitive position."

This is just a single example of how Taylor's new TRANSET Control system is helping refiners get top quality product at minimum operating cost. Why not talk it over with your Taylor Field Engineer! Or write for **Bulletin 98097.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

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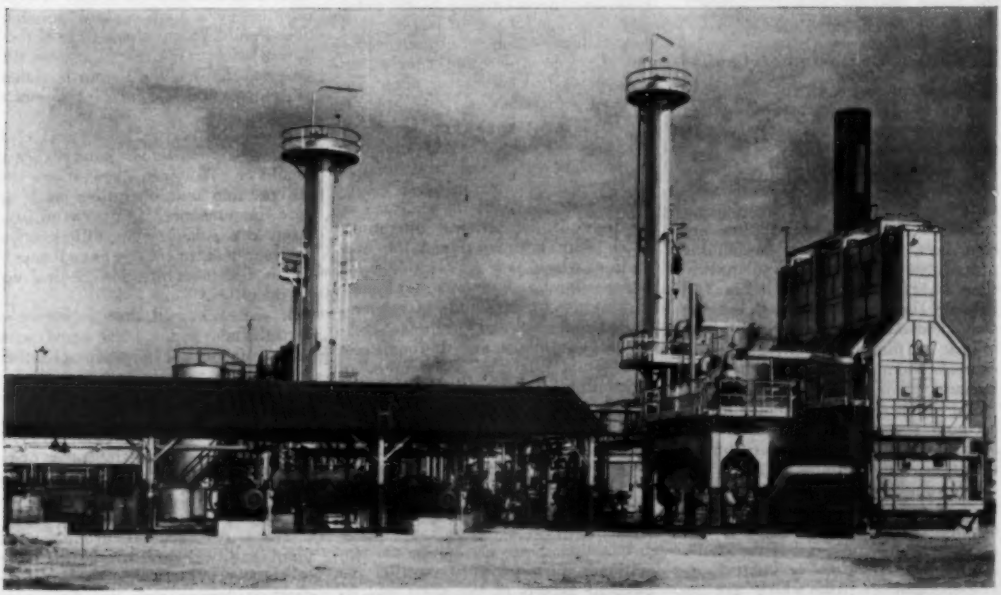

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

the needed production schedule, and to accomplish this in a manner to obtain the maximum earning.

3) General executives, including corporate officers, need reports of the broadest scope and, as far as practical, carefully summarized or condensed. These individuals are concerned with results of a longer term in order to direct the activities of their own company to meet the external forces of society.

All of these executives and supervisors have one common objective, that of conducting the enterprise on a profitable basis. This, of course, will result from maximum accomplishment at minimum expenditure. For this there is no magic formula. The ever-changing situations, both within and surrounding the enterprise, demand constant surveillance of the trend of cause and effect. The only source of adequate knowledge of such surveillance is the accurate record of current activities. This record can be produced through the channels of cost accounting, and the solution to the various problems will result from an adequate analysis of this record. The first step, therefore, is to set up and maintain a cost accounting system which will yield the data as needed by the men charged with the responsibility of directing the operation. The system must yield detailed data for those who are concerned with specific activities, as well as summary results for those charged with the broader aspects of co-ordination.

Accounting for Operations Control

This discussion will not attempt to present a complete cost accounting system for a petroleum refinery. Certainly the sound principles of accounting are being applied by all successful operators. It is possible, however, that in an enterprise so complex as petroleum refining some misapplications have been made of sound accounting procedures and some possible applications have been overlooked. The full value of the accounting which is being conducted may not be realized due to a lack of thorough analysis. Let us examine the nature of the oil refinery business in an effort to disclose fallacies which may have crept into our accounting practices, and to uncover activities wherein further accounting detail may be profitable.

In order to expedite our considerations, we can divide the field of refinery accounting into two broad classes according to the end use of the result.

One class, *financial accounting*, includes those records which are required to represent the manufacturing activities for purposes of legal and financial control. Such records are compiled through the established procedures of balance sheet accounting. The accumulated accounts may or may not bear a specific relationship to the physical activities which were performed in the plant. The definition of many of the accounts is set by the accepted legal and financial practices. A review of this phase of accounting is not within the scope of this paper.

The second broad class of refinery accounting, which may be referred to as *operational accounting*, includes those records which are useful to manufacturing management as a basis for the active direction of manufacturing manipulations. It is this class of accounting which may be worthy of further consideration.

The basic data entering into these two broad classes of accounting records originate from the same sources of expense. As dictated by the end use of the record, the treatment of the data must follow different courses if the results are to be of useful form. In *financial accounting*, the data must be grouped according to generally accepted business classifications. Many of these groupings have no common denominator which bears a relationship to the elements of the manufacturing activities which produced the result. In contrast to this, for *operational accounting* to be useful in the direction and analysis of manufacturing activities, the data must be grouped and recorded in a system more nearly parallel to the physical aspects of the plant operation. The facts must be presented in a fashion which will relate cause and effect in order that conclusions may be reached and future action intelligently directed.

But the most meticulous recording of data in a system carefully designed to represent specific elements of the activity will produce, in itself, no results. These data must be analyzed in the light of the physical operations which were performed and the production which was realized. Such analyses must embody our best knowledge of the fundamentals of economics, enginnering and process technology. Continuous and thorough cost analyses of this type based upon an accounting record which segregates accounts definable in terms of significant operating variables, will yield knowledge of value in operations control.

The foundation of an adequate system of cost accounting and analyses is the *chart of accounts* for expense distribution. Since accounting for operational purposes must parallel the physical aspects of the plant and its operation, the chart of accounts must be subdivided sufficiently to permit the definitions of the accounts to be accurate and realistic for individual parts of the plant and fundamental elements of its operation. In order to facilitate accounting manipulations, it is customary to use some system of letter or number symbols to represent the various accounts. It is highly significant that such a system of accounts and symbols be arranged in a manner to accrue costs to significant cost centers and to detail accounts having a characteristic common denominator.

Summation of Accounts

The summation of all accounts represents, of course, the operation of the entire plant. The first subdivision of the entire plant should be that of grouping all of the facilities which are involved directly in the refining of a barrel of oil into what may be termed *productive facilities*, and grouping all of the activities which do not have to do specifically with the refining processes into what may be termed *additional plant expense*. The general group of *productive facilities* may or may not be further subdivided into *light oil processes*, *lubricating oil processes*, and *auxiliaries*.

The group of *productive facilities* will include all unit processes such as crude distillation, cracking, vapor recovery, specialty stills, treating plant, pumping, loading rack, boiler house, water distribution, water treating, fuel distribution, and control laboratory. Each such unit process should be represented by a unit expense account. Care should be exercised in the definition of each unit process, so that the start and the finish of the work of that process can be recognized and measured.

The nonproductive facilities grouped as *additional plant expense* should be subdivided likewise into the recognizable unit operations such as yard maintenance, fire protection, safety department, plant offices, engineering department, general supervision, fire insurance and medical department.

It will be noted that maintenance facilities have not been listed with either of the above groups. Further examination will indicate that by far the greater amount of maintenance applies to the true *productive facilities;* therefore, it will be equitable in most cases to classify the maintenance overhead facilities such as storehouse, mechanical shops and automotive machines as *productive facilities*.

These two general groupings of plant facilities represent our first move to classify operations according to a common denominator. Broadly speaking, the total expenses for the *produc-*

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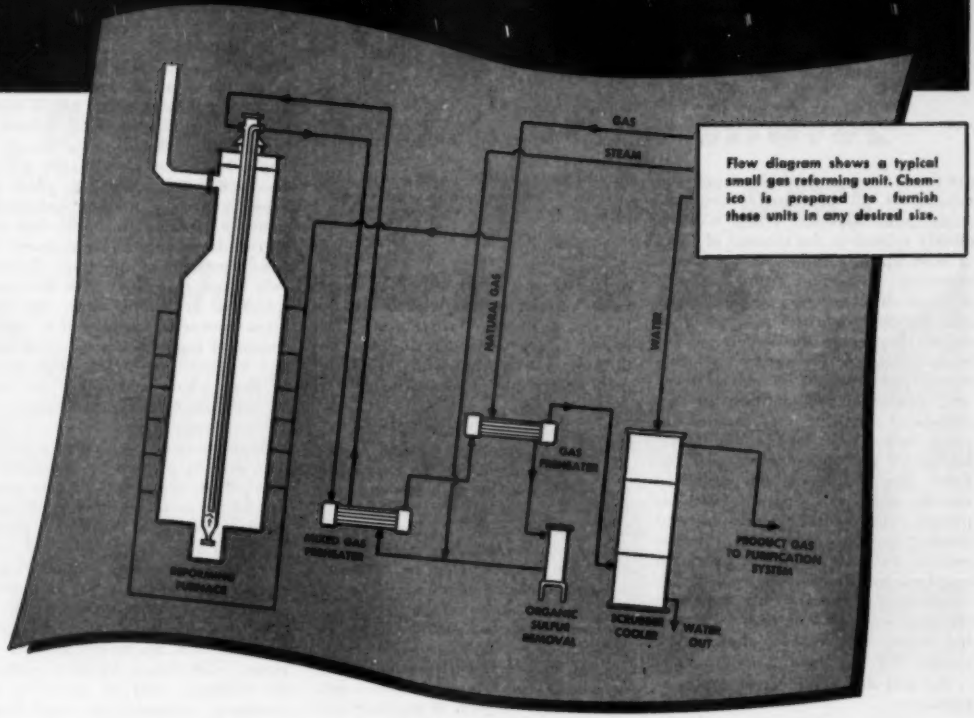

Flow diagram shows a typical small gas reforming unit. Chemico is prepared to furnish these units in any desired size.

Chemico offers units for the production of hydrogen mixtures by the catalytic reforming of hydrocarbon gases such as natural gas, propane and butane. For synthesis work, product gas can be limited to trace amounts of impurities. Other Chemico units may be used to produce controlled ratio mixtures of hydrogen with carbon monoxide, carbon dioxide or nitrogen.

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Chemico plants are profitable investments

TABLE 1

Departmental Expenses

UNIT SIX MONTHS

	July	August	September	October	November	December
INPUT—BARRELS						
Operation						
Labor—Direct $						
Labor—Supervision $						
Labor Burden $						
Supplies and Miscellaneous $						
Fuel $						
Fuel MM Btu.						
Steam $						
Steam M Lbs.						
Power $						
Power KWH						
Water $						
Water M Gallons						
Sub Total $						
Maintenance						
Labor—Direct $						
Labor—Supervision $						
Labor Burden $						
Material $						
Sub Total $						
Total $						

tive facilities bear a relationship to the volume of oil processed. The *additional plant expenses* group is more closely related to the element of time, at least within a rather wide scope of operation. As a result of this, we have a rough differentiation between fixed and variable expense as applied to major changes in the volume of oil being processed. The specific elements of expense involved in each of these unit processes or facilities are accumulated according to a detailed expense code. These detail codes should be limited in scope and precisely defined. The detail code may identify specific items of apparatus such as pumps, control equipment, piping and vessels; specific items of supplies or services such as chemicals, operating supplies, telegrams, maintenance material, stationery and printing; or specific types of pay roll such as operating labor, maintenance labor, supervision, sick leave and vacation time.

We will define typical examples as follows:

Division	1.	Productive Facility
Unit	48.	Boiler House
Detail	100.	Operating Labor
Detail	300.	Operating Supplies
Detail	500.	Maintenance Labor
Detail	600.	Maintenance Material
Detail	3.	Vacation Pay
Detail	55.	Water Purchased
Detail	13.	Pumps

Then specific expense charges will be identified as:

Vacation pay for boiler house operator	1-48-103
Water purchased for boiler house	1-48-355
Maintenance labor to repair boiler house pumps	1-48-513
Maintenance material to repair boiler house pumps	1-48-613

A system of maintenance job cost accounting can be added by including a section in the code for work order numbers. For example, Work Order 217 may read, "Replace shaft in pump No. 14 at the boiler house." The code covering these charges would read as follows:

For Labor	1-48-513-217
For Material	1-48-613-217

The expenses will accrue to Work Order 217 and clear to Unit 48 for the plant expense statement. The closed work order carrying the details of cost is filed with the equipment record file of Pump No. 14.

Expense Statements

It is conventional practice to use the calendar month as the accounting period to close the accounts and summarize the results. The complete detail of all accounts should be available to the group handling process and economic studies. Due to operating variations serious errors in cost factors can result from summaries made for a prescribed period such as one month or six months. No expense data is of use for analytical purposes unless the specific accomplishment is known definitely. Some elements of expense, such as fuel burned, must be related to a known operating condition, while other expense items such as maintenance must be studied over a long period of time. Generally speaking the longest possible period over which operating conditions remain constant will give the most reliable cost data. It is obvious that the derivation of useful cost factors cannot be produced through routine accounting channels. This activity must be carried out through the proper collaboration of accounting, operating and technical agencies. This is the most critical phase of effective cost control, yet the portion of the work that is most frequently slighted. The most elaborate system for cost analysis and process economic study will come to naught if reliable cost factors are not available.

With the detail of expense accumulated for the accounting period, summary statements can be prepared as desired. For each level of management, statements should be prepared commensurate in detail with the nature of that manager's responsibility. An operating department supervisor will wish to see the expenses of each unit process under his jurisdiction expressed as: operating labor supervision, labor burden, fuel, utilities, operating supplies, maintenance labor and maintenance material. Such statements should be prepared monthly for every department or unit cost center. The maintenance supervisor will wish to see the detailed expenses incurred by each job work order which comes to his department. A suitable form of departmental statement is shown in Table 1. The works manager will be concerned with the total plant expenses expressed in the fundamental elements of labor, material, fuel and overhead accounts. Since expenses become a measure of operating efficiency only when associated with the corresponding accomplishment, the total plant statement is enhanced by the inclusion of input cost, production value and a statistical profit. The nature of data which makes up this type of summary statement is shown in Table 2 (page 90).

Since results for a limited period of time may be colored by operating irregularities, statements of this nature should be prepared in a progressive fashion, giving the results for preceding periods for comparison and to indicate any prevailing trend.

The specific handling of certain features of the accounts is worthy of consideration. We referred above to labor burden as an element of expense. This labor burden includes the company cost of annuity and insurance, vacation pay, sick leave pay, holiday pay, federal old age benefit taxes, unemployment insurance taxes, and workmen's compensation insurance. These expenses are related directly to the pay roll, and in total are equivalent to a substantial portion of the pay roll. A better understanding of labor costs will be obtained if this labor burden expense is recorded along with the pay roll to which it is associated. It will also be noted that no reference has been made to any proration of expenses. All prorations should be avoided. In most cases, the proration will be empirical and of significance only as defined. A more useful cost report will result if the general and overhead expenses are reported as such permitting proration as needed in the solution of

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TABLE 2
Manufacturing Expense

REFINERY _____ YEAR _____

		January	February	.....	November	December
1	Productive Facilities' Expense					
2						
3	Operation					
4	Labor					
5	Labor Burden					
6	Fuel—Refinery Products					
7	Fuel—Purchased					
8	Power—Purchased					
9	Water—Purchased					
10	Chemicals					
11	Supplies and Miscellaneous Expense					
12						
13						
14	Total					
15	Maintenance					
16	Labor					
17	Labor Burden					
18	Material					
19	Contracts					
20						
21	Total					
22	Productive Facilities' Expense—Total					
23	Additional Plant Expense					
24	General Plant Overhead					
25	Facilities and Services					
26	Taxes and Insurance					
27	Credits					
28						
29	Total					
30	Total Direct Plant Expense					
31	Miscellaneous Charges					
32	Depreciation					
33	Overhead, Division or Company					
34						
35	Total					
36						
37	Total Input Cost					
38	Production Value					
39	Profit or (Loss)—Statistical					

specific problems. The cost of plant produced utilities such as steam should be distributed among the unit processes on a volume as well as a dollar basis. The true cost of steam includes fixed costs such as depreciation and taxes, semi-fixed costs such as operating labor and maintenance, along with the variable costs of fuel and boiler feed water. The unit cost of steam varies with the total plant demand. The individual users of steam should be advised of the incremental cost of steam as will apply to any increase or decrease in the quantity used.

Production Value

This careful compilation of expense factors is essential in order to have the required tools for the analysis and study of all operating variables. But even though comparisons of manufacturing expenses are useful and important, these comparisons may lead to erroneous conclusions if considered alone. Many situations arise where a change in operation with increased expenses is justified because of the greater degree of product upgrading. The accomplishment of the refinery, therefore, also must be measured in some manner so that it can be compared with the expenses incurred in its achievement. Although simple operations can be measured by physical means, such as yield and quality indices, such measurement is not adequate for complex operations. For the latter, especially for presentation in summary reports, the accomplishment or production of the refinery should be translated into dollar values. When so translated, it becomes a factor along with expenses and raw material costs in the determination of the profit for the period.

The presentation of all these factors together on a single statement helps to emphasize their interrelationships and to keep before the reader of the statement the importance of the final net profit. The manner of determining the dollar value of refinery production is important. In financial accounting all production is valued at cost until sold or disposed of otherwise. Therefore, with large inventories common to petroleum refining and with the volume of sales in a month rarely or never in step with current production, it is apparent that book profit for a short period is not fully satisfactory for operating control. The book profit for any month reflects not only the profit on sales from current production, but also sales from prior production, methods of costing inventories, and other factors.

The most satisfactory means of calculating profit for the purpose of operating control requires the evaluation of current actual production based on average refinery billing prices in effect throughout the month. In this way the accomplishment of the refinery shown in dollars will not reflect inventory fluctuation and other factors not applicable to the period. This evaluation of the current production should be arrived at by the realistic pricing of the actual production, both finished and unfinished. No attempt should be made to theorize a one hundred per cent finished yield, since this would involve assumed end products which may not fit the demand schedule, and assumed incremental capacity which may not be present in the existing equipment. In other words, value the production which actually resulted from the plant as it was operated for the period and in keeping with the expenses which were actually incurred.

Input Cost

The third major element contributing to the result from a given operation is that of raw material or *input*. It will be found helpful to define *input* to include all raw materials and charge stocks which become a part of finished production, such as crude oil, natural gasoline, compounding materials, additives, tetraethyl lead and dye. By this definition we will avoid clouding the expense statement by some very costly items which are dictated by factors completely outside the jurisdiction of the plant operator. Furthermore, the handling of many of the non-petroleum materials is little more than simple brokerage. For example, tetraethyl lead is frequently reported as chemical expense under the heading of *treating and blending*. In most cases the magnitude of the TEL cost will be many times greater than the total of all other expenses in that unit. Possible economies in actual treating and blending manipulations may be overlooked since they appear small in so large a total. By removing the cost TEL from this account, minor improvements in operating technique will reflect in the expense statement. Still more pronounced distortions of this type can result in the use of compounding agents in lubricating oil and grease manufacture.

Cost Control

Finally, a well integrated system of expense accounting, cost analysis and economic study can serve only as the vehicle for cost control. Control must result from the action taken by an informed management. The compilation of data is of no avail if an effort is not made to interpret those data in terms of physical activities and to search for improved methods of conducting the activity in question. The largest single items of expense are labor and fuel burned. The greatest contributors to an excess of these costs are poor facilities and incorrect manipulation. The responsibility for improved results rests with an informed supervisory and technological staff armed with the authority to act.

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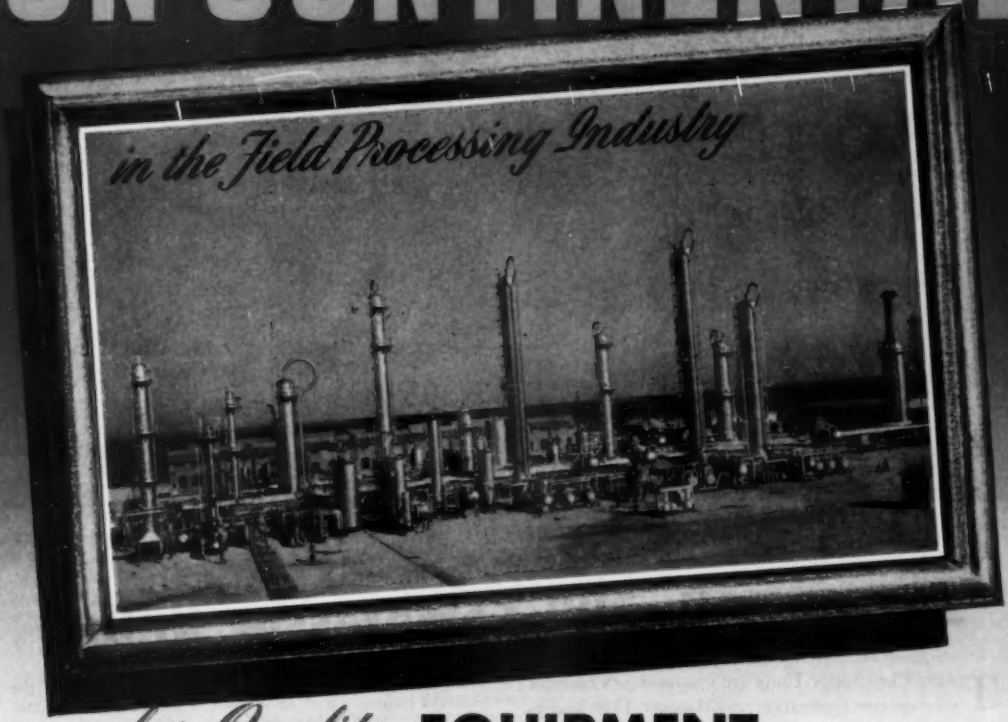

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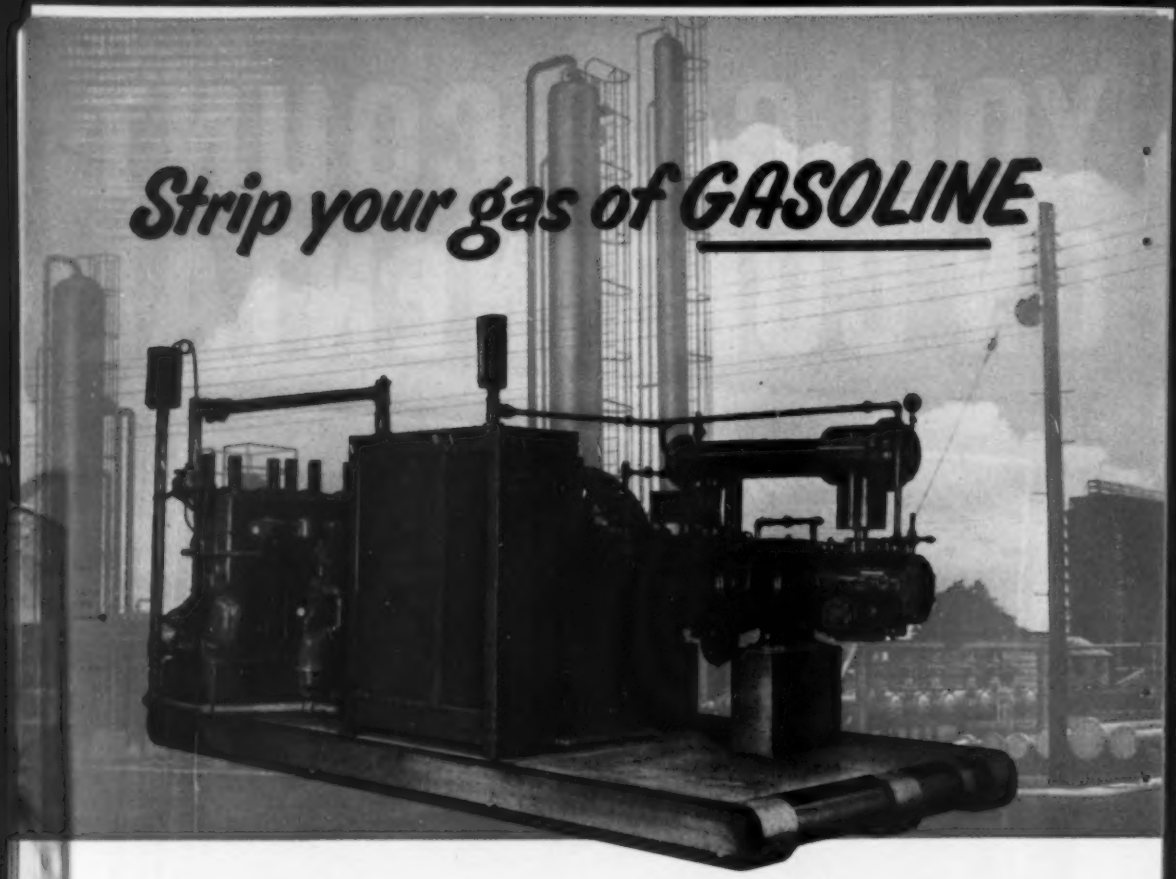

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PLANT NEARING COMPLETION—An artist's impression of Anglo-Iranian Oil Company's new Kent refinery on the Isle of Grain, near London, as it will appear when completed. Construction started in 1950. It is planned that the refinery, which is due to go on stream with a production of 42,000 barrels a day this summer, will be running at its full capacity of 84,000 barrels a day by the end of the year.

News Notes on Refinery and Other Plant Construction

Petroleum Refiner's quarterly "Box Score" tabulation starts on page 97

Socony-Vacuum Reports Record Refinery Operations

Socony-Vacuum Oil Company, Inc., has reported record operations last year by its refineries, both domestic and foreign. At the same time it announced plans for 35 million capital expenditures for refinery replacement and expansion this year. Final 1951 figures show the company's 16 domestic refineries processed an average of 520,000 barrels daily, a 10 percent increase over 1950, and its five western European refineries averaged 90,000 barrels daily for an increase of 36 percent.

A $27 million construction project for three Thermofor catalytic reforming units and a catalyst manufacturing plant will make up the company's major investments this year. The new TCR units will be located at Torrance, Calif.; Beaumont, Texas, and Augusta, Kan., and the catalyst plant at Paulsboro, N. J.

Texaco Plans $44 Million Lube Oil Plant In Illinois

A $44,550,000 high viscosity lubricating oil plant designed to produce 3485 barrels per day of high viscosity motor and aircraft engine oils and dewaxed cyclinder and gear oils at Lockport, Ill., has been announced by The Texas Company. In addition, plans call for expanding crude capacity 25,000 barrel per day and increasing avgas production 740 barrels per day and motor gasoline 11,721 barrels per day. The portion of the project has not been certified yet.

Nippon to Expand Refining Facilities With Caltex Aid

Nippon Petroleum Refining Company, Ltd., with the aid of funds provided by the Caltex group of companies, is embarking upon an expanded oil refining capacity program in Japan. The Caltex group, through an affiliate, California Texas Corporation, has agreed to lend Nippon Petroleum $19 million for the refinery construction program. The loan has been approved by the Japanese foreign investment board.

AIOC Modernizing South Wales Refinery Jetties

Part of the expansion scheme in progress at the Anglo-Iranian Oil Company's Llandarcy, south Wales, refinery is the modernization of the jetties in the petroleum harbor, Queen's Dock, Swansea. Five timber jetties are being replaced by reinforced concrete ones, four of which are now in use; the last is expected to be ready in the spring. The refinery is now running at a daily capacity of 84,000 barrels.

Sulfuric Acid Plant to Be Constructed at Sao Paulo

A contact sulfuric acid plant with a 60 ton capacity has been ordered by S. A. Reunidas F. Materazzo in Sao Paulo, Brazil, to utilize local sulfur-bearing pyrite ore. The plant has been ordered from the contractor, Chemical Construction Corporation, and is being engineered by the Brazil Export Company.

Projects Get DPA Approval For Rapid Tax Amortization

These projects have received the Defense Production Administration's approval for rapid tax amortization during a two week period ended February 29: Socony-Vacuum, Paulsboro, N. J., bead catalyst for petroleum refining, $4 million, 75 percent; Koppers Company, Kobuta, Pa., benzene and petrochemicals, $2 million, 90 percent; Ashland Oil and Refining, Findlay, Ohio, gasoline refining, $1,707,000, 65 percent, and $411,111, 45 percent ($2.1 million); Dow Chemical Company, Freeport, Texas, benzene, $1,210,000, 90 percent; California Company, Rangely, Colo., butanes, natural gasoline, propane, $700,000, 65 percent; Neville Company, Anaheim, Calif., petroleum polymen resines, $73,450, 45 percent.

Standard Oil Company (Ohio), Lima, Ohio, alkylation feed stock project, $12,375,000; Standard Oil Company (Ohio), Cleveland, Ohio, alkylation feed stock project, $6,719,000; Magnolia Petroleum Company, Midland and Upton counties, Texas, natural gas and butane project, $8385; Phillips Petroleum Company, Ector County, Texas, propane, mixed butanes and pentanes project, $5,446,400; Pure Oil Company, Norfolk, Va., petroleum products, $213,680, 40 percent; Ashland Oil and Refining Company, Louisville, Ky., gasoline, $585,000, 65 percent, $605,000, 45 percent; Phillips Petroleum Company, Great Falls, Mont., petroleum refining, $1,135,000, 45 percent.

Stanolind Oil and Gas Company, Grant County, Kans., isobutane, $286,000, 90 percent; Texas City Refining Company, Texas City, Texas, aviation alkylate, $2,480,000, 50 percent; Cities Service Company, Pampa, Texas, gasoline, $222,139, 65 percent; Esso Standard Oil Company, Baton Rouge, La., octyl alcohol, $326,000, 70 percent; Sinclair Refining Company, Houston, barium sulfonate, $98,650, 65 percent; Warren Petroleum Corporation, Tulsa, propane and butane, $566,320, 65 percent; Phillips Petroleum Company, Borger, Texas, cyclohexane, $1,230,990, 90 percent and $325,090, 45 percent; Phillips Petroleum Company, Borger, Texas, propane, isobutane, $111,418, 40

percent, $1,852,050, 65 percent, $19,190, 15 percent.

Del Ray Petroleum Company, Eagle Lake, Texas, natural gasoline, butanes, propanes, $364,009, 65 percent and $7413, 15 percent; Deep Rock Oil Corporation, Cushing, Okla., high viscosity lube oil, $1,625,000, 65 percent, $225,000, 45 percent; Stanolind Oil and Gas Company, Andrews County, Texas, natural gas, $2,338,853, 65 percent, and $445,706, 20 percent; Shell Oil Company, Deer Park, Texas, avgas components, $1 million, 90 percent; Standard Oil Company of California, Richmond, Calif., lube oils, $950,700, 65 percent, and $50,500, 40 percent and $48,800, 15 percent; Shell Oil Company, Martinez, Calif., sulfonates, $414,000, 65 percent, and $62,000, 40 percent.

Monsanto Chemical Company and Tide Water Associated Oil Company, Avon, Calif., sulfuric acid, $2,050,000, 35 percent; Union Oil Company of California, Oleum, Calif., motor gasoline and Diesel fuel, $84,780, 65 percent; Standard Oil Company (Indiana), Wood River, Ill., additives for oil, $116,500, 65 percent, and $56,150, 45 percent; The Texas Company, Los Angeles and Wilmington, Calif., products and refining, $404,100, 65 percent, and $812,230, 40 percent; Standard Oil Company of California, San Francisco, phenol, $4,605,000, 50 percent, and $723,000, 45 percent, with $12,000, 15 percent.

Contract for Two Atlantic Processing Units Awarded

A contract for the design and construction of two major processing units at Atlantic Refining Company's Point Breeze refinery in Philadelphia has been awarded to The M. W. Kellogg Company. This multi-million dollar expansion program includes the world's largest Orthoflow fluid catalytic cracker and an alkylation plant for the production of alkylate. The Orthoflow unit will have a reactor thruput of 45,000 barrels per day. For the production of aviation alkylate, a 3500-barrel-per-day sulfuric acid alkylation plant is also being engineered at the refinery. Construction on both units will start this spring with completion scheduled for 1953.

American Petrochemical To Build $20 Million Plant

American Petrochemical, a new company jointly owned by Cities Service and Firestone has announced it will build a processing plant for light hydrocarbons near Lake Charles, La., at a cost of $15-20 million. The plant will be supplied by a near-by Cities Service refinery. The first product will be ethylene, but a wide-range of plastics, synthetic rubber, lube additives, cracking catalysts and high volume petrochemicals will be added in the future.

Burmah Oil Company Will Build Pakistan Refinery

The Burmah Oil Company has been reported negotiating for permission to build a new $3.2 million refinery in Pakistan. Present plans call for the refinery to have a 10,000 barrel per day capacity.

Stanolind to Construct Sulfur Unit in West Texas

Stanolind Oil and Gas Company has announced plans for construction of a sulfur recovery unit at its North Cowden plant, 15 miles from Odessa, Texas. Stanolind previously announced that a similar unit was to be constructed by the Fluor Corporation at its Slaughter gasoline plant near Sundoyn, Texas. The North Cowden plant has been recovering propane, butane and natural gasoline from casinghead gas produced in the North Cowden field since early in 1950. The sulfur recovery unit there will be completed early in 1953. Fluor Corporation began construction on the Slaughter unit early this month, with completion scheduled for September of this year.

Anglo-Saxon Awards Plant Contract To Lummus Company

The Anglo-Saxon Petroleum Company Ltd., of London has awarded a contract for the design and construction of a natural gasoline plant to the Lummus Company Ltd. To be operated by the Concesionaria de Petroleuo Shell-Condor, the plant will process a small flow of raw distillate, together with 20 million cubic feet per day of wet gas for the recovery of LPG, motor gasoline and finished distillate. It will be a self-contained unit with its own power plant, cooling water system and tankage.

Lone Star Constructing Plant in Western Texas

Lone Star Producing Company, affiliate of Lone Star Gas Company, has completed plans for construction of a $3 million gasoline plant which will process casinghead gas from the Fort Chadbourne oil field in West Texas. Construction will begin immediately on the plant which will have a daily capacity of 30 MMcf of casinghead gas and will produce natural gasoline, propane and butane.

General Petroleum Receives OK on Wyoming Sulfur Plant

The Defense Production Administration has granted a certificate of necessity to the General Petroleum Corporation for a nautral gasoline and sulfur extraction plant to serve the Manderson and Slick Creek oil fields of Wyoming. Plans call for the plant to process in excess of 8 MMcf per day, while the sulfur plant's capacity will exceed 50 long tons per day. Both units, estimated to cost more than $4 million, will be located in Manderson field, being connected to Slick Creek wells by a 24-mile, 8-and-10-inch line, serving wells with a 32,000 barrels daily crude output. Construction will not begin until the third quarter of this year.

New Company Plans Sulfuric Acid Plant at Texas City

Texas City Chemicals, a recently formed company, has announced plans to build a $4.5 million plant to produce 300 tons of sulfuric acid per day and dicalcium phosphate. Land has been purchased but construction is not yet underway.

$26 Million Minnesota Oil Refinery Under Discussion

Sylvester Dayson, Texas oilman, has disclosed that he and a group of associates are discussing the possibility of building a $26 million refinery somewhere in Minnesota. Although certificate of necessity from the Defense Production Administration has been obtained, no definite site has been chosen. Dayson has said that the Great Northern Oil Company, located in St. Paul, has been formed to set up the project, but declined to name persons associated with him in the venture.

Cities Service to Build Oklahoma Gasoline Plant

A 4800-barrel-per-day natural gasoline plant at Blackwell, Okla., has been ordered by Cities Service Oil Company with construction to begin in the near future. Plant products will include isobutane, natural gasoline and liquid petroleum gas products. A pipeline will move the products to Cities Service refinery at Ponca City. Completion is expected early in 1953.

Esso Expands Construction Work at Baton Rouge Plant

Esso Standard Oil Company has announced that it intends to spend an additional $16 million on previously announced plans to expand its Baton Rouge, La., refinery. The added construction will boost the plant's projected 270,000 barrels-per-day capacity to 300,000 and will include new 30,000 barrel-per-day distillation facilities, expanded fluid catalytic cracking capacity, chemical treatment, blending, shipping and auxiliary facilities.

Caltex Overseas Expansion, Building Program Announced

The California Texas Oil Company, Ltd., has announced plans for expansion and new construction of refinery facilities in several countries by affiliated and subsidiary companies. Modernization of a 26,000-barrel-per-day fluid catalytic cracking unit has been scheduled by the Bahrein Petroleum Company, Limited, at Bahrein in the Persian Gulf, with completion date scheduled for early 1953. One idle column has been converted to a No. 5 crude still and is in operation.

In Europe, Caltex Petroleum Maatschappij (Nederland) N. V. is increasing its refinery at Pernis, near Rotterdam to 28,000 barrels per day capacity, an increase of 8000 barrels per day. Completion is expected by mid-1953. Maximum operation of the Societe de Raffineries de Petrole de la Gironde's refinery at Bec d'Ambes, near Bordeaux, will add an additional 1500 barrels per day when arrangements are completed in mid-1952, to give the plant a daily capacity of 16,500 barrels per day.

Caltex (Philippines) Incorporated has begun engineering work on a new refinery at Tatangas, south of Manila Bay, which will include a two-stage crude still, propane decarbonization and catalytic cracking units with a 13,000 barrels per day capacity. Completion is expected by July, 1954. Bitumen and Oil Refineries (Australia) Limited, (BORAL) has a 1500-barrel-per-stream-day platforming unit under construction

BROWN & ROOT, TOPS IN TOTAL CONSTRUCTION IN TEXAS

AUSTIN, Jan. 2 (AP) — Despite government controls on building, Texas construction contracts passed the billion dollar mark for the second time in history in 1951 and set an all-time record of $1,076,252,036 . . . .

The record-breaking overall total was reported today by Hanford Reed, editor of "Texas Contractor," building trade journal.

Numerous large single projects were put under contract in 1951 . . . . The Lone Star steel plant which was awarded to Brown & Root, Inc., of Houston was in excess of $70,000,000 . . . .

Brown & Root led all contractors in dollar value. "Texas Contractor" estimated the firm won contracts totaling close to $200,000,000.00.

"A turning point in Texas' post-war construction boom was reached in July 1951," Reed said in an editorial for the Jan. 1 issue. "Up to mid-year, the construction industry as a whole, in common with many other segments of Texas economy, had been operating at levels never before reached in history . . . ."

Reed predicted the dollar value of Texas construction would continue high because of new projects necessary to the defense effort.

Inside Red China's Army, Regime

Brown & Root construction men are busy over the globe, building an astounding variety of heavy industrial plants and facilities. Wherever they are . . . Guam, Mexico, Canada, the Caribbean . . . Brown & Root jobs are tops in workmanship, speed, and economy. An inquiry will put our staff at your disposal.

BROWN-BILT

BROWN & ROOT, Inc. *Engineers • Constructors*

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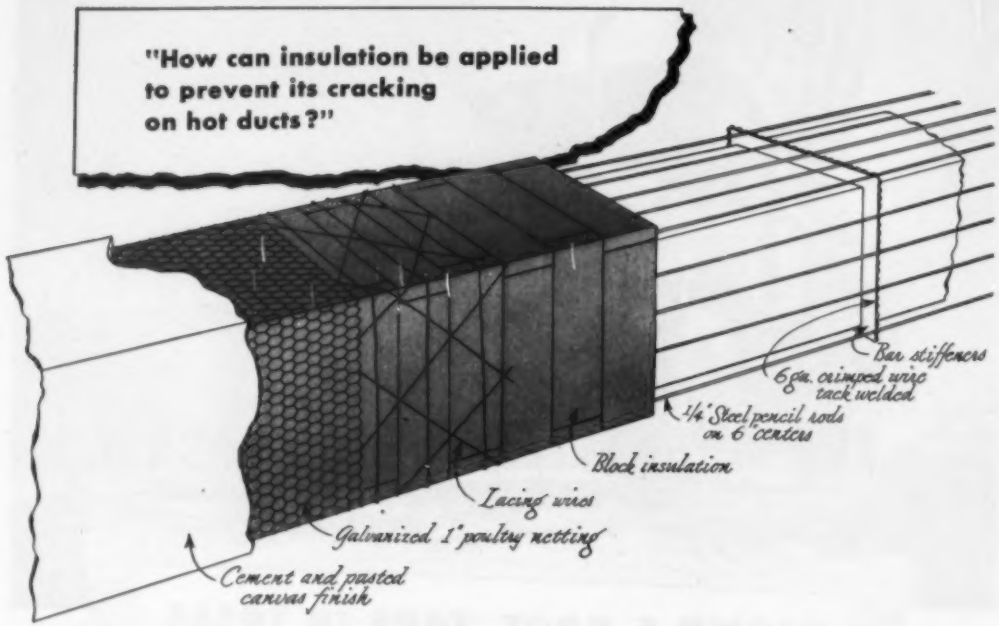
We have been asked:


"How can insulation be applied to prevent its cracking on hot ducts?"
Bar stiffeners
6 ga. crimped wire tack welded
1/4" Steel pencil rods on 6" centers
Block insulation
Lacing wires
Galvanized 1" poultry netting
Cement and pasted canvas finish

A plant engineer wrote to us recently and outlined this problem — "We plan to insulate a metal breeching which operates at a temperature of 400° F. How should the insulation be applied to prevent its cracking due to the expansion and contraction of the duct underneath?"

In answering this question, we made the following recommendation: We suggest insulating this duct with blocks of Armstrong's 85% Magnesia, 3" thick. Its top temperature limit of 600° F. allows a safety margin of 200° in this application. The blocks are applied as shown in the drawing above. First, the stiffeners are bridged with ¼" steel pencil rods on 6" centers. End joints should be staggered at least 18" apart, with all butting ends tack welded. The rods are held in place with 6-gauge crimped wire, tack welded to the stiffeners on approximately 6" centers. Care should be taken, however, to prevent the rods from being welded to the stiffeners.

Next, the blocks of 85% Magnesia are applied at right angles to the rods. They are held in place with black annealed wire laced around the rod and the block. 1" galvanized poultry netting is then stretched over the insulation and tied tightly to each intersection of lacing wire.

A rough coat of cement is then applied, thick enough to cover the wire mesh. This is followed with a finish coat of cement troweled smooth.

An 8-ounce canvas jacket, neatly pasted on, completes the job. If an expansion joint is used, it should be insulated separately, in the same manner as the duct.

Helping you find the right answers to your insulating problems is only a part of Armstrong's Insulating Service. We can take over the entire job for you—furnish top-quality materials plus skilled mechanics to apply them properly—and eliminate the costly failures that so often result from lack of knowledge or poor workmanship. Next time you're faced with any insulation problem, contact your near-by Armstrong representative. He will be glad to show you how you can take full advantage of Armstrong's *complete* insulation service — and be *sure* of a thoroughly professional job.

SEND US YOUR QUESTIONS: If you have any questions on insulating materials or their use in high- or low-temperature installations, please write us. We'll see that you get a prompt, practical answer. Just address your letter or post card to Armstrong Cork Company, 7504 Maple Street, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS

MATERIALS - INSTALLATION

FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.

at Matraville N.S.W. Australia with completion set for mid-1952. A company in the process of formation has commenced engineering work on a new refinery to include a two-stage crude still, propane decarbonization and fluid catalytic cracking units at Kurnell, near Sydney, Australia. January, 1955, has been set as completion date on this 22,000 barrel per day plant.

In Japan, the Koa Oil Company has under construction a modernization and expansion program to increase the capacity of its Marifu refinery to 10,000 barrels per day, an addition of 4000 barrels per day over current capacity. Engineering work has commenced on a platforming unit with a 1300 barrel per stream day capacity and on a solvent dewaxing and extraction plant. Both will be completed in 1953. The Nippon Petroleum Refining Company Limited has a modernization and expansion project under construction at its Yokohama refinery to increase the daily capacity to 12,000 barrels per day. Also under construction is a new atmospheric distillation unit, vacuum still, propane deasphalting unit and a fluid catalytic cracking unit. Completion is expected in 1954. At its Kudamatsu plant, a 1300-barrel-per-stream-day platforming unit is in the engineering stages with completion set for late 1953.

ASPPA Signs With Eastern For Aviation Alkylate

The Armed Services Petroleum Purchasing Agency is negotiating a contract with Eastern States Petroleum Company of Houston in its current aviation alkylation expansion program. Contract terms call for the rehabilitation of existing but non-operative World War II facilities in the Houston area with an estimated alkylate production of 2100 barrels per day. From this, Eastern is expected to produce approximately 5000 barrels per day of 100/130 aviation gasoline when combined with other components.

ASPPA has reached the signing state on another contract calling for 150 barrels per day of alkylate to be produced from new facilities. However, the name of the company involved will not be released until negotiations are completed.

Consolidated Chemical's Sulfur Plant in Operation

Their $500,000 plant for the recovery of sulfur from waste gases from Esso Standard's Baton Rouge plant has been reported in operation by Consolidated Chemical Industries. A 400-ton-per-day sulfuric acid plant is now under construction to utilize acid sludge from Gulf Coast refineries at Baton Rouge.

Construction

Canadian Refining Program Depends on Material Supply

If the Petroleum Administration for Defense releases scarce construction material, Canada will probably add almost 95,000 barrels daily to her refining capacity as part of a world-wide expansion plan now being studied by Defense Production Administration. During the same 18-month expansion period, the U. S. will increase its capacity by 712,000 barrels daily. Most of the $300 million expansion in Canada will take place in the western areas of the country.

Midland Gasoline Plant Begins Initial Operation

Operations at the new Tex-Harvey gasoline plant near Midland, Texas, were begun before construction was completed in order to reduce the volume of gas being flared in the area. Capacity operation is scheduled to begin this fall at a throughput rate of 35-50 Mmcf. of natural gas to compare with the current 10 Mmcf. being processed. The J. B. Gill Company designed the plant.

More construction items on page 215.

Refinery and Other Plant Construction

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
Allied Chemical	Hopewell, Va.	Synthetic Nitrogen	†80,000 tons yr.	$12.5 million					
Allied Chem. & Dye	N. Claymont, Del.	Chem. plt.		$3.5 million	Under Constr.	1952			
Allied Chem. & Dye	Buffalo, N.Y.	Aromatics Fac.		$6,940,000	PAD Certified				
*Ashland O&R	Catlettsburg, Ky.	Refinery Exp.			Announced				
*Ashland O&R	Louisville, Ky.	Gasoline Exp.		$2 million	Certified DPA				
*Ashland O&R	Buffalo, N.Y.	Expansion		$3.5 million	Under Constr.	1953			
Atlantic Refining Co.	Philadelphia, Pa.	Detergent Mfg. Facilities		$1.5 million	Under Constr.			Atlantic	Ferguson
Atlantic Refining Co	Philadelphia, Pa.	Catalytic Reforming Unit	11,000 bbls.	$4 million	Under Constr.	Mid 1952	Atlantic	Badger Div.	Badger Div.
Atlantic Refining	Philadelphia, Pa.	Two stage pipe still. Cat; Alky; Poly Units	50,000 bbl.	$5.0 million					Badger Div.
Atlantic Refining	Philadelphia, Pa.	Sulfuric Acid Plt.	3,500 bbls.	$3,314,000	Under Constr.	1953		Kellogg	Kellogg
*Atlantic Refining	Philadelphia, Pa.	Orthoflow Cat. Cracking	45,000 bbls.		Spring Constr.	1953		Kellogg	Kellogg
*Atlantic Refining	Philadelphia, Pa.	Syn. Ammonia Plt.	100 tons		Contracted				Hydrocarbon
California Refining	Barber, N. J.	Expansion	47,000 bbls.		Under Constr.	1952			
Cambridge Gas Light Co.	Cambridge, Mass.	Light Oil Recov	24 mmcf		Contracted			Blaw-Knox	Blaw-Knox
*Coastal Oil	Pt. Newark, N.J.	Storage Fac.		$275,000	PAD Certified				
*Davison Chemical	Baltimore, Md.	Catalyst Mfg. Plt.		$210,494	Certified DPA				
Delta Refining	Memphis, Tenn.	Airlift Cat. Crk	3,000 bbls.	$1.8 million	Under Constr.	Late 1952	Socony Vac.	Koch	Koch
Delta Refining	Memphis, Tenn.	Cat. Poly.; gas conc; crude distillation revamp	†2,000 bbls.		Under Constr.	Late 1952		Koch	Koch
Dewey & Almy Chemical Co.	Cambridge, Mass.	Synthetic Rubber Addition		$404,000					
Du Pont	Deepwater Point, N. J.	Tetraethyl Lead Fac.	140,000 lbs.	$3.4 million	Under Constr.	1953			
Esso Petroleum	Everett, Mass.	Expansion-crude	†9,500 bbls.		Under Constr.	June, 1952			Foster Wheeler
Esso Standard	Bayonne, N. J.	Crude Dist.	20,000 bbls.		Under Constr.	Late 1952		Lummus, SOD & Foster Wheeler	Lummus, SOD & Foster Wheeler
		Atmos Pipe Still	28,500 bbls.						
*Esso Standard	Bayway, N.J.	Refinery Prod. Exp.			Announced				
*Esso Standard	Everett, Mass.	Expanded Gasoline Fac.			Announced				
Esso	Everett, Mass.	Fluid Cat. Crk	†18,500 bbl.		Under Constr.	Early 1953		SOD	Foster Wheeler
Esso	Everett, Mass.	Rerun pipe still	†7,000 bbl.		Under Constr.	1952		SOD	
Ethyl	Edgemor, Del.	Tetraethyl Lead		$184,125	PAD Certified				
Frontier Oil Ref	Erie City, N. Y.	Basic Ref. & Alkylation		$1.1 million	PAD Certified				
*Geon (Goodrich)	Calvert City, Ky.	Petro chem. Plt.			Under Constr.	Late 1952			
Gulf Oil	Harmarville, Pa.	Research Lab.		$1.1 million	Under Constr.	June, 1952		Gulf	Seaman
Gulf	Philadelphia	Crude; Atoms. & Vacuum Unit	125,000 bbls.		Designing	Summer 1953		Foster Wheeler	Foster Wheeler
Gulf	Philadelphia	Gasoline Sweetening	40,000 bbls.		Designing	Summer 1953		Gulf	

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Gulf	Philadelphia	Cat. Ref'ers.	10,000 bbls.		Designing	Summer 1953			
Gulf	Philadelphia	Cat. Cracker	63,000 bbls.		Designing	Summer 1953		Kellogg	Kellogg
*Hercules Powder	Delaware Area	Petrochemicals (Phenol)		$8 million	Under Constr.	1953			
Kendall Refining	Bradford, Pa.	Cat. Reformer	1,500 bbl.	$913,671	Completed		U.O.P.	U.O.P.	Procon
Koppers	Kobuta, Pa.	Styrene Monomer		$4 million	Design				
Mathieson Hydrocarbon Chemical Corp.	Brandenburg, Ky.	Chemical Plt.		$17 million	Under Constr.			Badger Div.	Badger Div.
Mathieson	Don Run, Ky.	Isobutane Facilities	6,000 bbl.	$10 million	Completed				
M. F. A. Oil	Memphis, Tenn.	Cat. Crk. & Aux.	2,200 bbl.	$1.7 million	Engineering				
Monsanto	Charleston, W. Va.	Enlarg. Chem. Facilities		$9 million	Engineering	Spring, 1953			
*Monsanto	Springfield, Mass.	Polyvinyl chloride resin		$1.2 million	Announced				
*Pure Oil	Norfolk, Va.	Petroleum Prod.		$213,680	Certified DPA				
Sinclair Ref.	Marcus Hook, Pa.	Sulfur Extraction	20 tons	$320,000	Under Constr.			Parsons	Parsons
Socony-Vacuum	Paulsboro, N.J.	Expansion	45,000 bbl.	$12-15 million	Under Constr.	3rd Qtr., 1952		Staff-Braun	Braun
Socony Vacuum	Paulsboro, N.J.	TCC Unit	15,000 bbls.			3rd Qtr., 1952		Staff-Fluor	Fluor
*Socony-Vacuum	Paulsboro, N.J.	Products Exp.			Announced				
*Socony-Vacuum	Paulsboro, N.J.	Bead Catalyst Mfg.		$4 million	Certified DPA				
Sun Oil	Marcus Hook, Pa.	Lube Oil Plt.	8,400 bbls.	$2.5 million	Under Constr.	April, 1952		Sun	Sun
Sun Oil	Marcus Hook, Pa.	Aromorber and Houdriformer	10,000 bbls.	$8.4 million	Engineering	Fall 1952	Sun-Houdry	Texas	Sun
Union Carbide and Carbon Co.	Institute, W. Va.	Coal Hydrogenation Pilot Plt. Lab.	300 tons coal	$11 million	Announced				
United Refining Co.	Warren, Pa.				Under Constr.				
U. S. Industrial Chemical	Baltimore, Md.	Ethyl Alcohol Plt.		$328,515	Announced				
MID-CONTINENT									
Allied Chemical & Dye Corp.	South Point, O.	Synthetic Nitrogen	50,000 tons yr.	$12.5 million	Design				
American Cyanamid	Michigan City, Ind.	Synthetic Cat. Prod.	To 400 tons	$5 million	Under Constr.	June, 1952		Blaw-Knox	Blaw-Knox
Ashland Oil & Ref.	Canton, Ohio	Fluid Cat. Crk.	8,000 bbls.	$4 million	Under Constr.		U.O.P.	U.O.P.	McKee
Ashland	Canton	Cat. Poly Unit	600 bbls.		Under Constr.		U.O.P.	U.O.P.	McKee
Ashland	Canton	Add. Crude Topping	20,000 bbls.		Under Constr.			U.O.P.	McKee
			†7,500 bbls.		Under Constr.			U.O.P.	McKee
*Ashland O&R	Findlay, Ohio	Gasoline Mfg.		$2.6 million	Certified DPA				
Aurora Gasoline Co.	Detroit, Mich.	Platforming Unit	6,000 bbls.		Under Constr.	Completed	U.O.P.	U.O.P.	Staff
Aurora Gasoline	Detroit, Mich.	Basic Refining		$400,000	Announced				
*Ben Franklin Refining	Ardmore, Okla.	Expansion	†4,500 bbls.	$2 million	Under Constr.				
Bureau of Mines	Otis, Kans.	Reopen Heli. Plt	48 Mcf/yr.	*$3 million	Under Constr.				
Cities Service Oil Co.	Chicago, Ill.	Grease-Making Fac.	8.8 million lbs.		Planned				
Cities Service	E. Chicago, Ind.	Fluid Hydroformer	10,000 bbls.		Design	Late, 1952		Kellogg	Kellogg
Cities Service	Blackwell, Okla.	Nat. Gasoline Plt.	4,800 bbls.	$3,880,000	PAD Certified	Early 1953			
Cities Sv. Oil-Del.	Ponca City, Okla.	Fluid Cat. Crk.	8,350 bbl.	$6.5 million	Completed	1952		Kellogg	Kellogg
Cities Sv.-Del.	Ponca City	Crude Vacuum	24,000 bbl.						
Consumers Coop.	Phillipsburg, Kans.	Cat. Crk. Unit	5,000 bbls.	$2.6 million	Under Constr.	Feb., 1953	U.O.P.	Ref. Eng.	Ref. Eng.
		Dist. Expansion	†4,000 bbls.		Under Constr.	Mid 1953		Ref. Eng.	Ref. Eng.
*Continental Oil	Ponca City, Okla.	Expansion	None	$7.5 million	Start Spring	Mid 1953			
Deep Rock Oil	Cushing, Okla.	Aromatics Fac.		$3,230,000	PAD Certified				
Deep Rock Oil	Cushing, Okla.	Lube Oil Plt.	930 Finished		Engineer	Dec., 1952		Kellogg	Kellogg
*Deep Rock Oil	Cushing, Okla.	Lube Oil Expan.		$1.8 million	Certified DPA				
Derby Oil Co.	Wichita, Kans.	TCC Cat. Poly Gas Concent.		$2 million	Under Constr.	4th Qtr., 1952	Socony Vac., U.O.P.	Fluor	Fluor
Detroit Chem. Wks.	Detroit, Mich.	Sulfuric Acid		$950,000	PAD Certified				
Dow Chemical	Midland, Mich.	2nd Hypersorption Unit			Under Constr.		Union Oil (Calif.)	Foster Wheeler	Foster Wheeler
Dow Chemical	Ludington, Mich.	Bromine for TEL	2 million lbs. yr.	$433,500	Under Constr.				
Dow Chemical	Midland, Mich.	Ethylene Dibromide		$370,000	Under Constr.				
Dow Chemical	Midland, Mich.	Vinyltoluene Plt.		$5 million	Constr. Fall	July, 1952		Stone & Webster	Stone & Webster
Dow-Corning	Midland, Mich.	Methyl Chloride		$620,000	Under Constr.	Sept., 1952		Staff	Staff
*El Dorado Refining	El Dorado, Kans.	Expansion	†4,000 bbls.	$3 million	Under Constr.			Ref. Eng.	Ref. Eng.
Great Northern	St. Paul, Minn.	Crude Topping	30,000 bbls.						
Great Northern Oil	St. Paul	Cat. Crk.	7,620 bbls.	$26 million	Certified DPA				
Great Northern	St. Paul	Cat. Reformer	6,000 bbls.						
Great Northern	St. Paul	Cat. Poly.	680 bbls.						
Gulf Oil	Cincinnati, Ohio	Canning Plt.			Announced				
Hugoton Plains Gas and Oil	Tyrone, Okla.	Iso-Butane Expansion	11,000 bbls.	$119,250	Completed			Pritchard	Pritchard
International Refineries	Carlton City, Minn.	Refinery	11,500 bbls.	$7 million	Under Constr.	Oct., 1952	S.O.D.	Lummus	Lummus
Johnson Oil Ref. Co.	Cleveland, Okla.	Platforming	1,800 bbls.	$750,000	Completed	1951	U.O.P.	U.O.P.	Procon
Kanotex Refining	Arkansas City, Kans.	Vacuum Unit	4,600 bbl.	$2.4 million	Under Constr.	June, 1952	U.O.P.	U.O.P.-Ref.Eng.	Ref. Eng.
Kanotex	Arkansas City	Fluid Cat.	5,700 bbl.						
*Kerr-McGee	Duncan, Okla.	Asphalt Plt. React.		Leased Sunray	Completed			Staff	Staff
Lakeside Refining	Kalamazoo, Mich.	Cat. Reformer			Contracted	1952	Phillips	Koch	Staff
*Leonard Refineries	Alma, Mich.	Expand. Crk. Capacity	†4,000 bbls.					Cat. Constr.	Cat. Constr.
Lion Oil	El Dorado, Ark.	Av-Gas Expan.	432 bbl.	$810,000	Under Constr.				
*Lion Oil	El Dorado, Ark.	Cat. Crk. Unit	5,000 bbls.	$5 million	Announced	Late 1953			
*Lion Oil	El Dorado, Ark.	Alkylation Plt.	1,150 bbls.						
Mathieson Chem.	McKamie, Ark.	Sulfur Extrac.		$198,990	Contracted			Fluor	Fluor
Mercury Oil Refining	Oklahoma City	Cat. Crk.; Poly.	2,500/360 bbl.	$3.2 million	Design	Late 1952		Ref. Eng.	Ref. Eng.
Mercury	Oklahoma City	Topping; Thermal	5,000/1,800 bbl.						
Michigan Chem.	St. Louis, Mo.	Sulfuric Acid		$81,681	PAD Certified				
*Mid-Continent Petroleum	Tulsa Co., Okla.	Aviation Gaso. Fac.		$119,572	Certified DPA				
*Midland Coop. Wholesale	Cushing, Okla.	Capacity Exp.	†4,000 bbls.		Engineering Studies	Studies	U.O.P.		

• CONTINUED ON PAGE 101

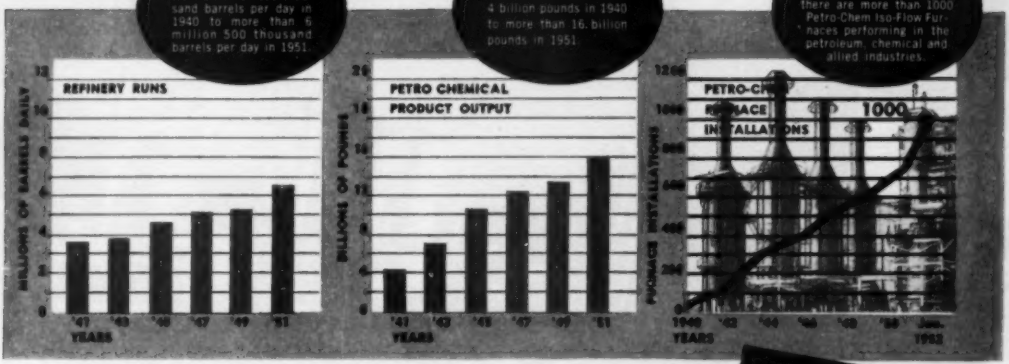
CONFIDENCE spells growth

There's many a reason for the parallel growth of the Petro Chemical Industry and the increasing use of Petro-Chem Iso-Flow Furnaces by leading Petro Chemical Companies.

Runs to stills in U. S. oil refineries increased from 3 million 500 thousand barrels per day in 1940 to more than 6 million 500 thousand barrels per day in 1951.

Petro Chemical production has increased from 4 billion pounds in 1940 to more than 16 billion pounds in 1951.

In 1940 there was 1. In 1946 there were 400 and as of Feb 1952 there are more than 1000 Petro-Chem Iso-Flow Furnaces performing in the petroleum, chemical and allied industries.



ISO-FLOW FURNACE USERS KNOW . . . that the Petro-Chem Development Company has but one basic product; processing furnaces for petroleum, chemical and allied industries. As a result of experience, they know that it does not pay to build their own furnaces; that Petro-Chem Iso-Flow Furnaces cost less, operate efficiently and usually beyond their rated capacity . . . they know that all process data made available for the design and engineering of Petro-Chem Iso-Flow Furnaces is kept strictly confidential . . . never released by Petro-Chem Development Company engineers.

The Petro Chemical, Petroleum, Chemical and allied industries can be confident that as they grow in size and advance in technology, so Petro-Chem Iso-Flow Furnaces will keep pace.

There's a **PETRO-CHEM ISO-FLOW FURNACE** for every process requirement of the petroleum and chemical industries

for any | DUTY TEMPERATURE PRESSURE EFFICIENCY

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Minnesota Mining	Copley Twp., Ohio	Sulfuric Acid Fac.		$2.1 million	Under Constr.				
Monsanto Chemical	Addyston, Ohio	Styrene Plastics Plt.			Plan				
National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization, Fld. Cat. Crk., Add tnkge, Util.	22,000 bbls.	$2 million	Completed		U.O.P.	Ref. Eng.	Ref. Eng.
Natl. Petro Chemicals Corp.	Tuscola, Ill.	Ethane-Propane Nat. Gas		$32 million	Announced	Late 1952			
Natl. Petro Chem	Tuscola, Ill.	Petro Chem Plt.	600 mmcf	$32 million	Under Constr.	Late 1952			Vulcan, Pritchard, Foster Wheeler, Lummus
Northern Nat. Gas	Holcomb, Kans.	Gas Dehydration Plt. Addi.			Under Constr.	Jan., 1953		Dresser	Dresser
Northern Nat. Gas	Holcomb	Gas Refg. Plt.	165,000 mcfd		Under Constr.	Jan., 1953		Dresser	Dresser
Northwestern Refining	St. Paul Park, Minn.	Topping & Cracking Unit Expansion	30,000 bbl.	$3 million	Under Constr.	Aug., 1953		U.O.P.	Procon
Ohio Oil	Robinson, Ill.		10,000 bbls.		Supply	Early 1953			
Ohio Standard	Cleveland, O.	Crude Topping	7,000 bbl.	$4.2 million	Design				
Ohio Standard	Cleveland	Cracker; Poly	18,000/40 bbl.						
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls.	$40,000					
Old Dutch Refining	Muskegon, Mich.	Aromatic Fac.	150 B 370 T.	$515,120	Under Constr.				
Pana Refining	Pana, Ill.	Girbotol Unit			Under Constr.				Parker
Pan-Am Southern	El Dorado, Ark.	Revamp Poly for Tetramer	250 bbls.	$2.9 million	Completed				Staff
Peppers Refining	Oklahoma City	Revamp Units			Completed		Phillips U.O.P.		Staff-Kerh
Petroleum Spec.	Flat Rock, Mich.	Cat. Reformer	900 bbl.	$700,000	Under Constr.				
Petroleum Specialties	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$3 million	Planning				
Phillips Petroleum Co.	Okmulgee, Okla.	Cat. Crk. with Feed Prep. Unit & Gas Plt.		$4.5 million	Under Constr.	May, 1952		Fluor	Fluor
Phillips Petroleum	Okmulgee, Okla	Cat. Crk.; Others	7800 bbl.		Under Constr.	May, 1952		Fluor	Fluor
Pure Oil	Smiths Bluff, Ark.	Alkylate Fac.		$380,000	Under Constr.				
*Pure Oil	Toledo, Ohio	Alkylation Unit (Sulfuric Acid)		$2.5 million	DPA Ok'd Planning				
*Pure Oil	Toledo, Ohio	Modernization	30,000 bbls.		Start May	Spring 1953		Kellogg	Kellogg
*Pure Oil	Toledo, Ohio	Orthoflow Cat.	17,000 bbls.		Start May	Spring 1953		Kellogg	Kellogg
Roosevelt Oil & Refining	Mt. Pleasant, Mich.	Benzene Plt. and Auxiliary	1,140 bbls.	$1.5 million	Under Constr.			U.O.P.	Procon
Roosevelt O&R	Mt. Pleasant, Mich.	Platformer	1,750 bbls.		Under Constr.		U.O.P.	U.O.P.	Procon
Roosevelt O&R	Mt. Pleasant, Mich.	Catalytic (Benzene)		$1.5 million	Under Constr.			U.O.P.	Procon
Roosevelt O&R	Mt. Pleasant, Mich.	Extraction (Benzene)	12,000 bbls.		Under Constr.			Dow Chemical	Procon
*Shallow Water Refining	Scott Co., Kans.	Gasoline Mfg.			Announced				
Shell Oil	Wood River, Ill.	Expansion and Improvement	170,000 bbls.	$42.5 million	Under Constr.	Late 1953		Shell	Foster-Wheeler Fluor
Shell Oil	Wood River, Ill.	Expansion	150,000 bbls.	$42.5 million	Under Constr.				
Sinclair Refining	E. Chicago, Ind.	Refinery Expan.	30,000 bbl.		Under Constr.	Jan., 1953		McKee	McKee
Sinclair Refining	Hartford, Ill.	Gasoline Fac.		$34.4 million	PAD Certified				
Sinclair Refining	Hartford, Ill.	Crude Expansion	137,000 bbls.	$34,400	PAD Certified				
Sinclair Ref.	Wood River, Ill.	Sulfur Extraction Plt.	10,000 bbls.					Badger Div.	Badger Div.
Skelly Oil	Velma, Okla.	Booster Station			Planned				
Socony-Vacuum	E. St. Louis, Ill.	Alky. Unit Rehab.	775 bbls.	$260,000	Design				
Socony-Vacuum	E. Chicago, Ind.	Avgas Facilities		$4 million	Plan				
Standard-Ind.	Neodoska, Kans.	Cat. Crk.; Alky. Unit	9,300 bbl.	$10 million	Under Constr.	End 1952			
Standard-Ind.	Sugar Creek, Mo.	Crude Expan.	130,000 bbl.	$21 million	Preparing	End 1952			
Standard-Ind.	Sugar Creek	Olefin Concentrate		$142,000	Announced				
Standard-Indiana	Whiting, Indiana	Sulfur Recovery Plt.	55 tons	$1.7 million	Under Constr.	Middle 1952		Fluor	Fluor
Standard-Ind.	Wood River, Ill.	Alcohols Prod.	10 million lbs.	$2.6 million	Design	Mid 1952			
Standard-Indiana	Whiting	Benzene Expan.	1,044 bbls.		Announced	2nd Half 1952			
*Standard (Indiana)	Williston Basin, N. D.	New Crude Refinery	15,000 bbls.		Projected				
Standard Oil of N.D.	Grand Forks, N. Dakota	Refinery	2,000-2,500 bbls.		Planning				
Standard (Ohio)	Cleveland, Ohio	Crd. Dist. Plt.	48,000 bbls.	$61½ million	Under Constr.	Jan., 1952		McKee	McKee
Standard-Ohio	Toledo, Ohio	Alkylation Unit		$3 million	Early 1952	Mid 1953			
Standard-Ohio	Lima, Ohio	Crude Coking—		$2.4 million	Engineering			Sohio Research	
*Standard (Ohio)	Lima, Ohio	Cat. Reforming	3,000 bbls.	$8.5 million	Engineering	18 months			
		Alkylation Feed Unit		$12.3 million	Certified DPA				
*Standard (Ohio)	Cleveland, Ohio	Alkylation Feed Unit		$6.7 million	Certified DPA				
Stanolind Oil & Gas Co.	Tulsa, Okla.	Research Center			Planning			Shreve, Lamb & Harmon Assoc.	
*Stanolind O&G	Ulysses, Kans.	Gas Plt. Incrs.	1200 mmcf		Under Constr.	Mar. 15, 1952			
*Stanolind Oil & Gas	Grant Co., Kans.	Isobutane Mfg.		$1 million	Certified DPA				
Superior Refinery Owners, Inc.	Superior, Wis.	Topping	6,000 bbl.	$1.2 million	Completed				Ref. Eng.
		Thermal Crk.; Poly.	1000/24 bbl.						
Sun Oil	Toledo, Ohio	Platform Unit	10,000 bbls.		Under Constr.		U.O.P.		
Sunray Oil	Duncan, Okla.	Alkylation Fac.	2,100 bbl.	$1.7 million	Under Constr.	Aug., 1952	U.O.P.	Staff	Staff
Texas Co.	Lawrenceville, Ill.	Expand Refinery	720,000 bbls.		Under Constr.	1951		Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
*Texas Natural Gasoline	Tulsa, Okla	Gasoline, Propane, Butane			Announced				
*The Texas Co.	Lockport, Ill.	Lube Oil Plt.	3485 bbls.	$17.6 million	Certified DPA				
*The Texas Co.	Lockport, Ill.	Crude Expan., etc.	125,000 bbls.	$15 million	Not Certified				
Tide Water Assoc. Oil	Drumright, Okla.	Crude Topping; Vacuum	15,000 bbl. 6,000 bbl.		Design			Ref. Eng.	Ref. Eng.
*Vickers Petroleum	Potwin, Kans.	Crude Expan.	10,000 bbls.		Under Constr.	Jan 1, 1953		Sweco	Sweco
*Vickers Petroleum	Potwin, Kans.	Thermofor Cat. Cracking			Under Constr.	Jan., 1953	So-Vac.	Sweco	Sweco
Warren Petroleum	Cromville, Ill.	Isopentane Fac.		$40,350	PAD Certified				
*Warren Petroleum	Tulsa, Okla.	Propane & Butane		$566,320	Certified DPA				
*Western Reserve	Niles, Ohio	Crude Expan.	13,800 bbls.		Complete	Mar., 1952		Cat. Constr.	Cat. Constr.
*White Eagle Petroleum	Augusta, Kans.	Therm. Cat. Reform.			Projected				

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Wilcox Oil	Bristow, Okla.	Cat. Reformer	1,500 bbl.	$1 million	Under Constr.	Aug., 1952	U.O.P.	Procon	Procon
*Williston Refining	N. Dakota	Complete Refg.	10,000 bbls.	$5 million	Announced		U.O.P.		
Wood River Oil Refining	Calumet, Ill.	Crude Topping, Crak.; Poly.	15,000 bbl. 6,800/600 bbl.	$1 million	Design				
SOUTHWEST									
Acadia Corp.	Shreveport, La.	Motor gas unit		$2.9 million	Design				
*Allied Chemical & Dye (Solvay)	Orange, Texas	Petrochemicals Unit		$5 million	Projected	2 years			
American Petro-Chemical Corp.	Lake Charles, La.	Chem. Plt.	$15-20 million		Planned				
Aqua Dulce	Banquette, Tex.	Cycling Plt. Expansion		$750,000	Under Constr.	March 1, 1952		Fish Eng.	Fish Eng.
Arkansas-Louisiana Gas Co.	Blanchard, La.	4,300 hp Compressor Sta.	65,400 mcf		Under Constr.			Staff	Delta
Aromatics Refining	Baton Rouge, La.	Aromatics Fac.		$11.6 million	Design				
Atlantic Refining Co.	Port Arthur, Texas	Detergent Mfg. Facilities		$1.5 million	Under Constr.	Early Fall, 1952		Atlantic	Badger Div.
Atlas Processing	Shreveport, La.	Extractive Distill.	17,000 gals.	$2.6 million	Under Constr.	Mar., 1952	U.O.P.	U.O.P.	Hudson
Atlas	Shreveport	Platforming Unit		$6.5 million	Under Constr.	Mar., 1952	U.O.P.	U.O.P.	Procon
Barnsdall Oil Co., Op.	Scurry Co., Tex.	Natl. Gaso. Plt.	50,000 mcf gas	$1.7 million	Considering		U.O.P.	U.O.P.	Procon
Bay Petroleum	Chalmette, La.	Cat. Cracker	16,000 bbl.	$4 million	Completed	1952			
Cabot Carbon Co.	Bayou Sale, St. Mary Parish, La.	Thermal Black Plt.	126,986 lbs		Designing				
Cabot Carbon Co.	Bayou Sale, St. Mary Parish, La.	Oil Furn. Carbon Blk. Plt.	82,192 lbs.		Designing	1952			
Carbide & Carbon Chemicals	Texas City, Tex	Acetylene Plt.			Under Constr.	Early 1953			
*Carbide & Carbon Corporation	Texas City, Tex.	Polyethylene Resins Mfg.	140,000 lbs.		Under Constr.	Early 1953			
*Carbide & Carbon Corporation	Seadrift, Texas	Polyethylene & Ethylene Glycol Mfg.	140,000 lbs.	$43 million	Under Constr.	Early 1953			
Celanese Corp.	Pampa, Tex.	Chem. Plt.		$3.5 million	Under Constr.	June, 1952		Brown & Root	Brown & Root
Cities Service	Lake Charles, La.	Fluid Hydroformer	10,000 bbls.		Engineering			Kellogg	Kellogg
Cities Service	Lake Charles, La.	Avgasoline		$26.6 million	PAD Certified				
Cities Service	Lake Charles, La.	Crude Expan.	25,000 bbls.	$26,650,000	Announced				
*Cities Service Oil	Pampa, Texas	Gasoline Expan.		$222,139	Certified DPA				
Consolidated Chem. Ind.	Houston, Texas	Sulfur		$400,000	Announced				
*Consolidated Chemical, Ind.	Baton Rouge, La.	Sulfuric Acid	400 tons	$3.5 million	Under Constr.				
Continental Oil	Lake Charles, La.	Refinery Expan.	40,000 bbl.	$24 million	Under Constr.	Late 1952	U.O.P.	Badger Div., Conoco	Badger Div., Procon
Conden	Big Spring	Crude Distill.	4,000 bbls.		Under Constr.				
Conden Petroleum Corp.	Big Spring, Texas	Topping, Reforming, Aromatics Units	4,000 bbls.	$3 million	Under Constr.	Summer 1952	U.O.P.-Dow	U.O.P.-Dow	Procon
Crown Central Petroleum	Houston, Texas	Crude Topping	2,350 bbl.	$265,000	Design				
Crown Central	Houston	Cat. Cracker	2,400 bbl.	$7 million	Design	Early 1953		D & Z	Cound. Eng.
Davison Chemical	Lake Charles, La.	Catalyst Plt.			Under Constr.			O. L. Olson	O. L. Olson
Del Ray Petroleum Co.	Chesterville, Texas	Pressure Absorption Plt.	25,000 mcf						
*Del Ray Petroleum	Eagle Lake, Tex.	Nat. Gasoline		$4,000	Certified DPA				
*Del Ray Petroleum	Eagle Lake, Tex.	Butane & Propane			Certified DPA				Brown & Root
*Diamond Alkali	Houston, Texas	Petrochemicals Unit		$2 million	Contracted			Braun	Braun
Dow Chemical	Freeport, Texas	Styrene Plnation		$1.6 million	Under Constr.			Braun	Braun
Dow Chemical	Freeport	Ethylene-Dibromide Unit		$8 million	Under Constr.			Braun	Braun
Dow Chemical	Freeport	Perchlorethylene Chloride		$3 million	Under Constr.				
*Dow Chemical	Freeport, Texas	Benzene Addi.		$1.2 million	Certified DPA				
*Du Pont	Beaumont, Tex.	Petrochemicals Unit			Begin 1953				
E. I. Du Pont de Nemours & Co., Inc	Orange, Texas	Expand Polythene Manuf. Facilities	60 mmcf		Under Constr.	Late 1953			
*Eastern States Pet.	Houston, Texas	Benzene Mfg.	500 bbls.		Completed	April, 1952	U.O.P.	Staff	Brown & Root
*Eastern States Pet.	Houston Texas	Ethylene Mfg.		$4 million	Projected			U.O.P.	
*Eastern States Pet.	Houston Texas	Rehab. Closed Plt.			Army Contract				
Esso Standard	Baton Rouge, La.	Aromatics Fac.			Under Constr.				Staff
Esso Standard	Baton Rouge, La.	Crude Distill.	300,000 bbls.		Under Constr.	Early 1953		S.O.D.	Staff
Esso Standard	Baton Rouge, La.	Cat Cracker	31,000 bbls.	$51 million	Under Constr.	Early 1953		S.O.D.	Staff
*Esso Standard	Baton Rouge, La.	Crude Pipe Still	60,000 bbls.		Under Constr.	Early 1953		Kellogg	Kellogg
*Esso Standard	Baton Rouge, La.	Iso-octyle & Tridecyl Mfg. (alcohol)		$326,000	Announced				
Ethyl Corp.	Houston, Texas	Chemicals Mfg. Plt.	100 mln. lbs./yr.		Under Constr.	July, 1952		Braun-Badger Div.	Braun-Badger Div.
Ethyl-Dow	Freeport, Texas	Ethylene Dibromide	60,000 lbs.	$3.2 million					
Freeport Sulphur	Garden Is. Bay, La.	Sulfur Mining	1,400 tons	$10-15 million	Engineering	1953			Ford-Bacon-Davis
Gilmore Refineries	Odessa, Texas	New Refinery	50,000 bbls.	$40 million	Design				
Great Southern Chem.	Corpus Christi, Texas	Petro Chemicals		$5 million	Announced				
*Gulf Oil	Crane Co., Tex.	Sulfur Unit		$200,000	Certified DPA			Lummus	Lummus
Gulf Oil	Pt. Arthur, Tex.	Ethylene Plt.	45,000 lbs.	$15.4 million	Under Constr.	Spring, 1952		Gulf	
Gulf Oil Corp.	Pt. Arthur, Tex.	Iso-Octyl Alcohol Fac.	24,657 lbs.		Design	End, 1952			
*Gulf Oil	Port Arthur, Texas	Sulfuric Acid Plt.	300 tons	$2,318,855	Begin April, 1952			Leonard Constr	Leonard Constr.
*Gulf Oil	Port Arthur, Texas	Polymerization Plt.			Begin April,			Bechtel	Bechtel

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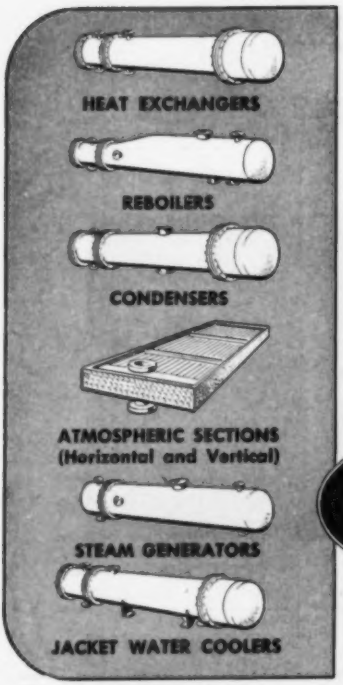

● If your problem is the poor performance or high maintenance cost of your heat transfer units, consult an EFCO engineer. He will help you decide the changes or modifications necessary to get the desired performance from your heat transfer equipment.

Backed by knowledge and experience, EFCO engineers are constantly working to produce heat transfer units that will give efficient performance and long, trouble-free operation.

ENGINEERS & FABRICATORS, INC.
P. O. Box 7395 Houston 8, Texas

EFCO
HEAT TRANSFER EQUIPMENT

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Gulf Oil	Waddell, Texas	Sulfur Extrac.	20 tons		Under Constr.	February, 1952		Gruff	Gruff
Gulf Oil	Port Arthur, Texas	Sulfur Recovery Unit	60 tons	$556,390	Designing	Fall 1953		Parsons	Parsons
Heyden Chemical	Houston, Texas	Methanol fr Natural Gas		$12 million	Announced				
Humble Oil	Baytown, Texas	Turbo Fuel Fac.	†4,400 bbls.	$70,400	Under Constr.	Winter Qtr.			
Humble Oil	Baytown, Texas	Pipe Still No. 5	†15,000 bbls.	$5 million	Under Constr.	Winter Qtr.		Foster Wheeler	Foster Wheeler
*Humble Oil	Baytown, Texas	Sulfuric Acid Fac.[1]		$608,000	Announced				
Koppers Co., Inc.	Pt. Arthur, Tex.	Chem. Plt.		$6 million	Under Constr.	1952		Koppers	Koppers
Levelland Refining	Amarillo, Texas	Cat. Crk: Poly.	3000/150 bbls.	$2.4 million	Design				
*Lone Star Producing Company	Ft. Chadbourne, Texas	Gasoline Plt.	30 mmcf	$3 million	Under Constr.				
Magnolia	Hurricane Creek Field, Beauregard Parish, La.	Cuninghead Gasoline Plt.			Designed				
Magnolia Petroleum	Pegasus Fld., Tex.	Gasoline Plt.	30 mcf		Completed			Hudson	Hudson
*Magnolia Petroleum	Beaumont, Tex.	Therm. Cat. Reforming	10,000 bbls.		Projected		So-Vac.		
*Magnolia Petroleum	Midland Co., Texas	Nat. Gas & Butane		$8.3 million	Certified DPA				
*Mayfair Minerals	McAllen, Texas	Natural Gas Plt.			Announced				
*McBride Refining	Edinburg, Tex.	Modernization	3,500 bbls.		Under Constr.				
*McBride Refining	Edinburg, Tex.	Catalytic Reform. Unit	800 bbls.		Under Constr.	July 1, 1952			
Monarch Refining	San Antonio, Texas	Fluid Cat. Crk.	4,000 bbl.						
Monarch	San Antonio	Poly. Unit	2,500 bbl.	$12.5 million	Design	Mid 1953		U.O.P.	Koch
Monarch	San Antonio	Alky. Unit	2,500 bbl.						
Monsanto	Texas City	Styrene Plastics		$96 million	Under Constr.	April, 1953			
*Monsanto	Texas City, Tex.	Vinyl Chloride		$7.3 million	Announced				
Monsanto Chemical Co.	Texas City, Tex.	Acrylonitrile Mfg. Facil.; Plt. Expansion		$30 million	Engineering	1952		Braun	
North American Oil Consolidated & Ungren & Frazier	Bartlett Field, Jones County, Texas	Gaso. Plt., Gas Injection Facilities			Planning				
Ohio Oil	Matagorda, Tex.	Gas Processing Plt.	91 million cu. ft.	$4.1 million	Under Constr.	Early 1953		Hudson	Hudson
Pan Am Petroleum & Trans.	Texas City, Tex.	Av-Gas Expan.	†1,150 bbls.		Plan	End 1953			
Pan Am Southern Corp.	Destrehan, La.	Cat. Crk. Unit Gas Plt., Alkylation	30,000 bbls.	$6.5 million	Planning	May, 1953		Lummus	Lummus
Pan-Am Southern	New Orleans, La.	Refinery Expan.		$6.5 million	Under Constr.				
Pan-Am Southern	Destrehan, La.	Fluid Hydroformer	2,000 bbl.		Under Constr.	May, 1952	S.O.D.	S.O.D.	Kellogg
Pan-Am Southern	Destrehan, La.	Coker	9,000 bbls.		Under Constr.			Lummus	Lummus
Pan American Refining	Texas City, Texas	Refinery Expan.	†12,000 bbls. Crude		Begin 1952				Lummus[1]
Pan American Refining	Texas City, Texas	Fluid Cat[1]	†30,000 bbls.[1] Cracking	$1.8 million					Texas-Gulf
Pan American Refining	Texas City, Texas	Poly Unit	†2,400 bbls. Avgas						
Panhandle Prod. & Ref.	Wichita Falls, Texas	Topping Unit	8,000 bbl.		Design			Ref. Eng.	
Panoma Corp.	Carson City, Tex.	Avgas		$1 million	PAD Certified				
Pecos Petroleum	Pecos, Texas	Aromatics Expansion	240/260 bbls.		Planned				
Phillips Chemical	Houston, Texas	Chem. Plt.		$2.5 million	Under Constr.	June, 1952			
Phillips Chemical Co.	Borger, Texas	Carbon Black Plt.	80,000 tons/yr.		Completed				
Phillips Oil	Borger, Texas	Alky. Expan.		$15.5 million	Announced				
Phillips Pet.	Chocolate Bayou, Texas	Nat. Gas Plt.	3,570 bbl.		Announced				
Phillips Pet.	Goldsmith, Tex.	Sulfur Plt.	120 tons	$1.7 million	Completed	Early 1952		Parsons	Parsons
Phillips Pet.	Midland, Texas	Nat. Gas Plt.	100 mcf		Under Constr.				
Phillips Petroleum	Sherman County, Texas	Natural Gas Plt		$212,000	Under Constr.				
Phillips Petroleum	Houston, Texas	Petrochemicals	400 tons	$38 million	Under Constr.				
Phillips Petroleum	Ector Cty., Tex.	Natural Gasoline		$900,000	PAD Certified				
Phillips Petroleum	Gray Cty., Tex.	Natural Gasoline		$409,612	PAD Certified				
Phillips Petroleum	Hutchinson City, Texas	Natural Gasoline Equip.		$169,165	PAD Certified				
Phillips Petroleum	Moore Cty., Tex.	Natural Gasoline		$1 million	PAD Certified				
Phillips Petroleum	Sweeney, Texas	Motor Fuel		$18,805,000	PAD Certified				
*Phillips Petroleum	Midland, Texas	Expanded Gasoline Mfg.		$9.6 million	Announced				
*Phillips Petroleum	Ector Co., Tex.	Butanes-Pentanes Mfg.		$5.4 million	Certified DPA				
*Phillips Petroleum	Borger, Texas	Cyclohexane Mfg.		$1.5 million	Certified DPA				
*Phillips Petroleum	Borger, Texas	Propane & Isobutane		$2 million	Certified DPA				
Pontiac Refining	Corpus Christi, Texas	Avgas Expan.		$2 million	PAD Certified				
Premier Pet.	Ft. Worth	Jet Fuel Butane, etc		$3.6 million	Design				
Premier Petroleum	Ft. Worth, Tex.	Platformer	1,500 bbl.	$650,000	Completed		U.O.P.	U.O.P.	
Premier Petroleum	Ft. Worth, Tex.	Refinery Expan.	6,000 bbls.		Planned				
Pure Oil	Smiths Bluff, Texas	Basic Refining		$10.8 million	Announced				
Pure Oil	Smiths Bluff, Tex.	Alkylate Unit	1,901 bbl.	$390,000	Announced				
Pure Oil	Smiths Bluff, Tex.	Fluid Cat. Crk.	26,000	$10.8 million	Start 1952			Kellogg	Kellogg
Pure Oil	Smiths Bluff, Tex.	Cat. Poly	135		Start 1952			Kellogg	Kellogg
Pure Oil	Smiths Bluff, Tex.	Expanded Alkylation	1,900 bbls.	$390,000	Start 1952			Kellogg	Kellogg
*Pure Oil	Smiths Bluff, Texas	Modernization		$11 million	Under Constr.	Spring, 1953		Kellogg	Kellogg
*Pure Oil	Smiths Bluff, Texas	Orthoflow Crk.	26,000 bbls.						
Pure Oil	Smiths Bluff, Tex.	Feed Prep-Vac Flash	20,000 bbls.		Start 1952			Kellogg	Kellogg
Republic Oil Ref.	Texas City, Tex.	Platforming Unit	6,500	$7 million	Begin Spring	Mid 1953	U.O.P.		
Republic Oil Ref.	Texas City, Tex.	Crude Dist.	†30,000		Begin later	Indefinite			
*Republic Oil Refining	Texas City, Tex.	Gasoline Mfg.		$6.6 million	Announced				
Shamrock Oil & Gas Corp.	McKee, Texas	Reconstruct Gaso. Ref. Treater		$80,000	Planning				

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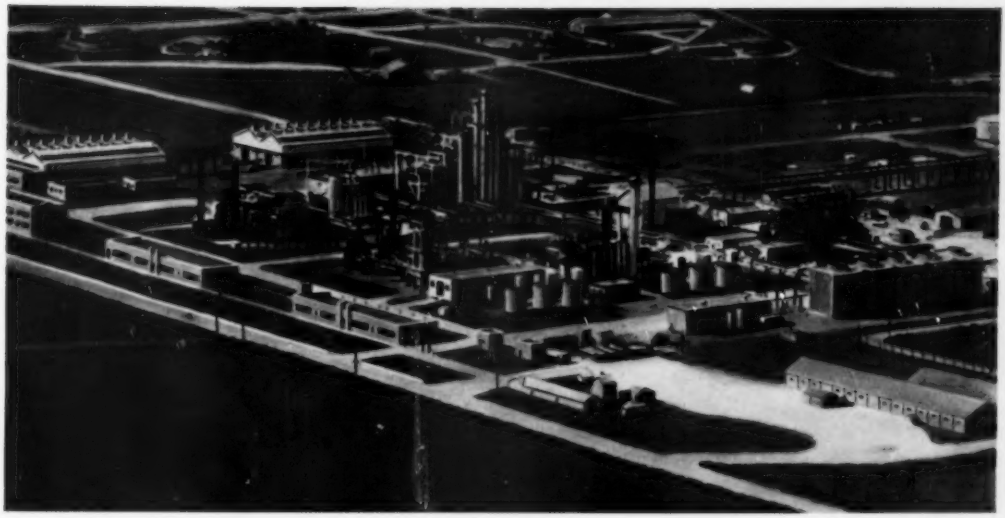

Overall View showing new facilities . . Ethylene Plant, Ethanol Plant and Isopropanol Plant

THE GIANT *of* GRANGEMOUTH

The British Petroleum Chemicals Ltd. plant at Grangemouth, Scotland, will supply the British Isles with a diversified line of important industrial chemicals and chemical intermediates derived from a crude petroleum stock. It was designed by Stone & Webster Engineering Corporation and built under the supervision of E. B. Badger & Sons Co. (Great Britain) Ltd.

STONE & WEBSTER ENGINEERING CORPORATION

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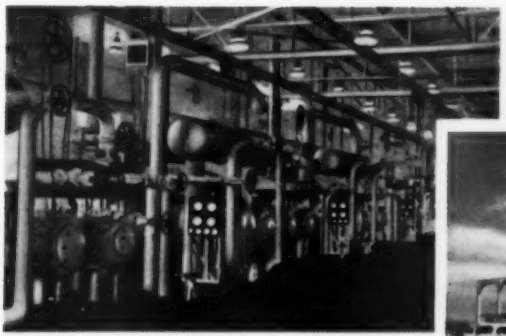
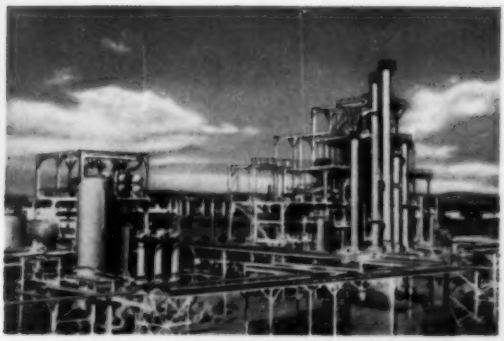


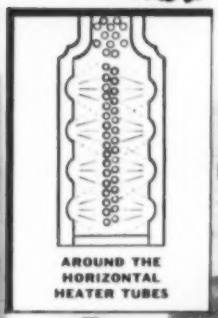
Compressor House — Interior

ETHYLENE PLANT
Cracking and Fractionating Structures



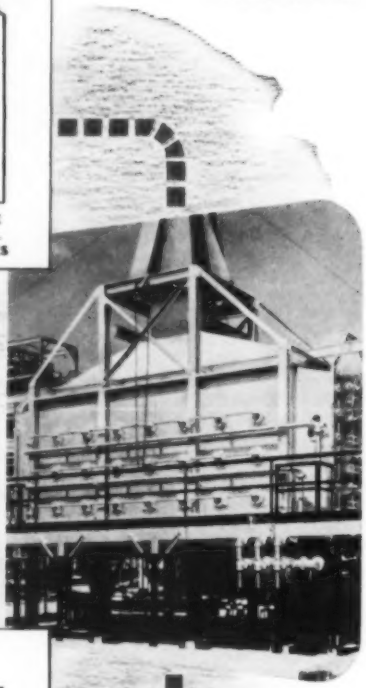
FASTER..UNIFORM..PROCESS HEATING IS IMPROVING YIELD QUANTITY..QUALITY

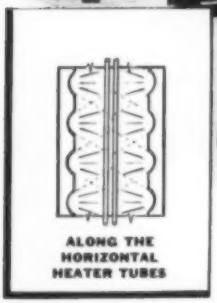
SELAS *Gradiation*® HEATERS



AROUND THE HORIZONTAL HEATER TUBES

Some applications of Selas Gradiation Heaters: Crude distillation, Vacuum distillation, Petroleum vaporization, Vis-breaking, High temperature cracking and heating, Superheating vapors.





ALONG THE HORIZONTAL HEATER TUBES

Radiant petroleum heaters—*Selas Gradiation Heaters*—processing the same catalytic cycle oil as conventional box furnaces, are yielding 40 per cent more gasoline and increasing the octane rating four to six points.

Major refiners have approved and applied Selas Gradiation Heater designs to obtain these and similar results, specifying heat rates that are far over the standards based upon operating experiences gained from conventional heaters.

The design principle of the SELAS GRADIATION HEATER is based upon:

1. Direct, controlled radiant heat distribution around and along the horizontal heater tubes.
2. Complete combustion, with little or no excess air.

The design of the Selas Heater provides:

1. High and uniform rates of heat transfer,
2. Positive rate-control of oil heating,
3. Low time-temperature charge residence, if that is a desirable processing factor,
4. Factory prefabrication, with as little as eight hours required for erection on sites,
5. Excellent fuel economy.

Uniform intensity of radiant heat is directed to all tube surfaces from the radiant burners. Flexibility is attained by sectional variation and control of the heating rate.

A completely descriptive Bulletin and other authoritative technical description are available upon request.

SELAS CORPORATION OF AMERICA
PHILADELPHIA 34, PENNSYLVANIA

Heat Processing Engineers for Industry · Development · Design · Manufacture

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Shamrock Oil & Gas	Sunray, Texas	Avis-Alkylate	.....	.....	Announced	.....	.....	.....	.....
Shamrock Oil & Gas	Sunray, Texas	Coking Unit	.....	.....	Under Constr.	Mid 1952	.....	Lummus	Lummus
Shamrock O&G	Sunray, Texas	Aviation Alkylate	16,000 bbls.	$2 million	Announced	.....	.....	.....	.....
Shamrock O&G	Sunray, Texas	Sulfur Extrac.	.....	$195,500	Announced	.....	.....	.....	.....
Shell Chemical Co.	Houston, Texas	Expand Ethylene & Ethyl Chloride Prod.; Glycerine Plt. Extension	.....	.....	Completed	.....	.....	Fluor	Fluor
Shell Chemical	Houston, Texas	Sulfur Recovery Unit	55 tons	$600,000	Under Constr.	Aug., 1952	.....	Parsons	Parsons
*Shell Chemical	Houston, Texas	Synthetic Glycerine Mfg.	.....	$1.5 million	Announced	.....	.....	.....	.....
Shell Oil	Houston, Texas	Benzene-Toluene	1,250/3,500 bbl.	$4.6 million	Under Constr.	Late 1952	.....	Foster Wheeler and Fluor	Foster Wheeler and Fluor
Shell Oil Co.	Houston, Texas	Platforming Unit	15,000 bbl.	$12 million	Under Constr.	.....	.....	U.O.P.	Procon
Shell Oil	Norco, La.	Expansion	†25,000 bpd	$30 million	Design	.....	.....	.....	.....
*Shell Oil	Houston, Texas	Avgas Components	.....	$1 million	Certified DPA	.....	.....	.....	.....
Sid N. Richardson	Odessa, Texas	Sulfur Recovery	20 tons	$120,630	Under Constr.	1952	.....	Graff	Graff
Sid Richardson Refining Co.	Texas City, Tex.	Refinery Alterations	30,000 bbls.	.....	Under Constr.	.....	.....	Staff	Staff
Sinclair Refining	Houston, Texas	Crude Topping	25,000 bbl.	$28 million	Field work	Fall 1953	.....	Staff-Fluor	Fluor; Braun
Sinclair	Houston	Cat. Cracker	40,000 bbl.						
*Sinclair Refining	Houston Texas	Barium Sulfonate	.....	$145,700	Certified DPA	.....	.....	.....	.....
*South Texas Corp.	Neuces Co., Tex.	Expanded Products Mfg.	.....	.....	Announced	.....	.....	.....	.....
Southwestern Oil & Refining	Corpus Christi, Texas	Crude Topping	15,300 bbl.	$5.5 million	Design	.....	U.O.P.	Ref. Eng.	Ref. Eng.
Southwestern	Corpus Christi	Cat. Crk.-Poly.	5,000/200 bbl.						
Standard (Texas)	El Paso, Texas	Alkylation Unit	1,400 bbl.	$2.7 million	Under Constr.	.....	.....	Kellogg	Cat. Constr.
Standard (Texas)	El Paso	Expansion & Modern Crk.	11,000 bbl.	$10.2 million	Under Constr.	July, 1952	Houdry	Cat. Constr.	Cat. Constr.
Standard (Texas)	Houston, Texas	Natural Gasol	.....	$1.2 million	Announced	.....	.....	.....	.....
Stanolind Oil	Shreveport, La.	Gas Stripping	1.5 million cu. ft.	.....	Under Constr.	.....	.....	Blaw-Knox	Blaw-Knox
Stanolind O&G	Sundown, Texas	Sulfur Recovery Unit	49 long tons	.....	Under Constr.	Sept., 1952	.....	Fluor	Fluor
*Stanolind O&G	Odessa, Texas	Sulfur Rec. Plt.	17.7 long tons	.....	Under Constr.	Early 1953	.....	Girdler Corp.	Girdler Corp.
*Stanolind O&R	Andrews Co., Texas	Nat. Gasoline	.....	$2.7 million	Certified DPA	.....	.....	.....	.....
Sunray	Corpus Christi, Texas	Cat. Cracking Refinery	28,000 bbls.	$16 million	Under Constr.	Summer 1953	U.O.P.	Lummus	Lummus
Sunray Oil Corp.	Scurry Cty, Tex.	Gasoline Project	.....	$7.5 million	PAD Certified	.....	.....	.....	.....
Taylor Refining	Corpus Christi, Texas	Aromatics Fac.	.....	$3.7 million	PAD Certified	.....	.....	.....	.....
*Taylor Refining	McAllen, Texas	Natural Gas Plt.	.....	.....	Announced	.....	.....	.....	.....
*Texas City Refining	Texas City, Tex.	Modernization	.....	$3 million	Engineering	1953	.....	Henry Kaiser Engineers	Henry Kaiser Engineers
*Texas City Refining	Texas City, Tex.	Modernization	.....	$3 million	Eng. Studies	1953	.....	Henry Kaiser Engineers	.....
*Texas City Refining	Texas City, Tex.	Avis-Alkylate	.....	$2.5 million	Certified DPA	.....	.....	.....	.....
Texas Eastman	Longview, Tex.	Petrochemicals	20,000 bbls. Propane	$5.7 million	Partial Oper.	.....	.....	.....	.....
Tex.-Harvey Gas	Midland, Texas	Gas Plt.; Refrig.	35 mcf wet	$5.5 million	Initial Oper.	July, 1952	.....	.....	.....
The Texas Co.	Pt. Arthur, Tex.	Expansion	20,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
*The Texas Company	Port Arthur, Texas	Gasoline Plt.	.....	$1,286,000	Approved DPA	.....	.....	.....	.....
*The Texas Company	Amarillo, Texas	Av-Gasol Fac.	.....	$20,750,000	Approved DPA	.....	.....	.....	.....
United Carbon Co.	Shamrock, Texas	Carbon Black Plt.	68,500 lbs.	$1.5 million	Under Constr.	.....	.....	.....	.....
United Gas Pipe Line	Sterlington, La.	Dehydration	†25,000 mcf	.....	Under Constr.	.....	.....	.....	Staff
United States Rubber	Baton Rouge, La.	Buna W Rubber Plt. Expan.	82,200 lbs.	.....	Under Constr.	Early, 1952	.....	.....	.....
*Universal Oil Products	Mooringsport, La.	Synthetic Cat. Mfg.	.....	.....	Announced	.....	.....	.....	.....
Wickett Refining	Wickett, Texas	Thermal Crker	2,000 bbls.		Under Constr.	.....	.....	.....	.....
*Wilshire & Lone Star Gas	Upton Co., Tex.	Nat. Gaso. Plt.	50 mmcf	$2 million	Under Constr.	May, 1952	.....	Staff	.....
ROCKY MOUNTAIN									
Arizona Interests	Florence, Ariz.	Refinery	15,000 bbls.	$25 million	Planning	1953	.....	Ebasco	.....
*Bay Petroleum	Denver, Colo.	Fluid Cat. Crk.	3,500 bbls.	.....	Under Constr.	Late 1952	U.O.P.	Procon	Procon
*Bay Petroleum	Denver, Colo.	Crude Expan.	6,000 bbls.	.....	Under Constr.	.....	.....	Procon	Procon
Bureau of Mines	Rifle, Colo.	Demonst. Reactors	150-400 ton	$333,870	Engineering	June, 1952	.....	Blaw-Knox	Staff
*California Co.	Rangely, Colo.	Products Addi.	.....	$700,000	Certified DPA	.....	.....	.....	.....
Continental Sulphur & Phosphate Corp.	Thermopolis, Wyo.	Sulfur Extraction	.....	.....	Planning	.....	.....	.....	Chemico
Farmers Union Central Exc.	Laurel, Mont.	Fluid Cat. Crker.	5,000 bbls.	$3.5 million	Under Constr.	Nov., 1952	U.O.P.	Ref. Eng.	Ref. Eng.
Filtrol Corp.	Salt Lake City, Utah	Catalyst Mfg.	140 tons	$4 million	Completed	.....	.....	Parsons	Parsons
*Frontier Refining	Cheyenne, Wyo.	Alkylation Prod.	.....	$2.5 million	Certified DPA	.....	.....	.....	.....
Garfield Chemical & Mfg. Corp.	Salt Lake City	Sulfuric Acid	.....	$2.5 million	Plan	.....	.....	.....	.....
*Gen. Pet. Corp.	Worland, Wyo.	Gasoline Ext. Plt.	8 mmcf	$4 million	Certified DPA	.....	.....	.....	.....
Oriental Refining Co.	Denver, Colo.	Perco Cyclovertion Unit	1,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Phillips Chem.	Eunice, N. M.	Sulfur Extrac.	100 tons	$1.5 million	Contracted	.....	.....	.....	.....
Phillips Petroleum	Lea Cty., N. M.	Natural Gasoline	.....	$27,150	PAD Certified	.....	.....	.....	.....
Phillips Petroleum Co.	Woods Cross near Salt Lake City, Utah	Vac. Plt., Gas Plt.; Storage, Cat. Crk.	8,000 bbls.	$10 million	Under Constr.	July, 1952	.....	Fluor	Fluor
*Phillips Petroleum	Woods Cross, Utah	Expanded Gasoline Fac.	.....	$5.7 million	Announced	.....	.....	.....	.....
*Phillips Petroleum	Great Falls, Montana	Refining	.....	$3 million	Certified DPA	.....	.....	.....	.....
Pure Oil	Worland, Wyo.	Sulfur Recovery Plt., etc.	30 million cu. ft. gas	.....	Engineering	.....	.....	Foster Wheeler	Tex. Gulf Sulphur
Utah Oil Ref.	Salt Lake City, Utah	Expansion: Treating, Storage	.....	$1 million	Under Constr.	Sept., 1952	.....	CB&I	CB&I and Sterns-Roger
Western States Refg.	Salt Lake City, Utah	Topping: Crker.	3,000/2,200 bbls.	$1.1 million	.....	.....	.....	.....	.....
WEST COAST									
American Smelting & Refining	Tacoma, Wash.	Sulfuric acid	.....	$891,720	Announced	.....	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Caminol Co.	Hanford, Calif.	Motor Gasoline & Distillate			Announced				
Dow Chemical	Pittsburgh, Cal.	Methylene Chloride		$670,000	Under Constr.	June, 1952			
Ethyl Corp.	Wilmington, Calif.	Gasoline Facilities		$184,125	PAD Certified				
Eureka Refining	Long Beach, Cal.	Cat. Crker.	6,000 bbls.	$2.2 million					
Fletcher Oil	Rancho San Petro, Cal.	Thermal Crker. Addition	700 bbls.	$176,250					
General Petroleum	Torrance, Calif.	Avgas Facilities		$575,000	Under Constr.	June, 1952		G. P. Staff	J. B. Gill
*General Petroleum	Torrance, Calif.	Therm. Cat. Reform.			Projected				
Hancock Oil Co.	Long Beach, Cal.	Ethylene Glycol	20,000 bbls.		Under Constr.				
Hancock—Calif.	Long Beach, Calif.	Aviation Gasoline		$3 million	PAD Certified			Badger Div.	Badger Div.
Hancock Chem.	Long Beach, Calif.	Sulfur Extraction Exp.	50 tons	$250,000	Under Constr.	Feb., 1952		Parsons	Parsons
*Mohawk Petroleum	Bakersfield, Calif.	Jet Fuel Prod.		$3 million	Announced				
*Monsanto	Avon, Calif.	Sulfuric Acid Plt.	250 tons		Engineering	End 1952		Monsanto	Leonard Constr.
Navy	San Joaquin, Calif.	Natural Gas Plt.	30,000 mcf	$5 million	Under Constr.				Parsons-Macco
Richfield Oil	Watson, Calif.	Expansion; Cat Cracker; Aromatics	6,000 bbls.	$43 million	Under Constr.			Braun	Braun
Rothschild Oil	Santa Fe Springs, Cal.	Cat. Crker.	6,000 bbls.	$2 million					
Shell Chemical	Shell Point, Calif.	Synthetic Ammonia Plt.			Planning				
Shell Chemical	Shell Point	Refinery	25,000-50,000 bbls.	$25 million	Planning				
Shell Chemical	Dominguez, Calif.	Synthetic Ammonia Plt.			Under Constr.	Late 1952			
*Shell Oil	Martinez, Calif.	Sulfonates		$476,000	Certified DPA				
*Shell Oil Co.	Wilmington, Calif.	Distillation Tower	52,000 bbls.		Adv. Design	Early 1954			
*Shell Oil Co.	Martinez, Calif.	Distilling Expan.	15,000 bbls.		Under Constr.	Sept., 1952			
Signal Oil & Gas	Los Angeles, Cal.	Butanes-Iso-butane		$500,000					
*Standard (Calif.)	Richmond, Calif.	Lube Oils		$1.5 million	Certified DPA				
Standard (Cal.)	El Segundo	Feed Preparation			Under Constr.	June, 1952		Fluor	Fluor
Standard (Cal.)	El Segundo	Platformer	10,000 bbls.	$7.4 million		June, 1952	U.O.P.	U.O.P.	Procon
Standard (Calif.)	Richmond, Calif.	Chem. Plt.		$1.5 million	Engineering				
Standard—Calif.	Richmond, Calif.	Synthetic Phenol		$4 million	Under Constr.				
Standard—Calif.	Richmond, Calif.	Benzene		$1,187,000	PAD Certified				
Standard Oil-Calif.	Richmond, Calif.	Vacuum Flasher	55,000 bbl.		Under Constr.			Kellogg	Kellogg
Standard Oil-Calif.	Richmond, Calif.	Modernization			Under Constr.			Kellogg	Kellogg
Standard Oil of Calif.	Richmond, Calif.	TCC to Houdry	7,500 bbls.	$9 million	Under Constr.	Dec., 1951	Houdry	Houdry	Betchel
Standard Oil of Calif.	El Segundo, Calif.	Benzene Plt.	650 bbls. Benzene, 3,300 bbls. Toluene	$10 million	Under Constr.	Mid 1952	U.O.P.	Fluor	Fluor
Stauffer Chemical	Compton, Calif.	Sulfuric Acid Fac.		$57,070	Engineering				
Stauffer Chemical	Richmond, Cal.	Sulfuric acid		$283,500					
Sunray Oil	Santa Maria, Cal.	Reconstruction	5,000 bbls.					Procon	Procon
Union Oil Co. of Cal.	Brea Olinda, Cal.	Research Plt.		$5 million	Projected			Austin, Field and Fry	Walker
Union Oil Co.	Los Angeles, Calif.	Fluid Cat. Crk. Unit	28,500 bbls.	$7 million	Under Constr.	June, 1952	U.O.P.	McKee	McKee
Union Oil	Los Angeles, Cal.	Crude Topping	20,000 bbls.	$12 million					
Union Oil	Los Angeles	Alkylate Fac.	250 bbls.	$135,000					
Union Oil	Wilmington, Cal.	Cat. Cracker	28,500 bbls.	$4.5 million					
Union Oil	Wilmington, Calif.	Acid Treater Rerun	15,000 bbls.		Under Constr.			Union-Braun	Braun
Union Oil	Wilmington	Av.-Gas		$135,000					
*Union Oil	Oleum, Calif.	Gasoline & Fuel Expan.		$84,780	Certified DPA				
Union Oil Co.	Edmonds, Wash.	Asphalt Refinery	65,000 tons		Under Constr.				Bechtel
Union—Calif.	Los Angeles, Calif.	I.C.C. Revision		$2.8 million	Under Constr.	June, 1952	Houdry	McKee	McKee
Union—Calif.	Los Angeles, Calif.	Crude Dist;	40,000 bbls.	$7 million	Under Constr.	Nov., 1952		Fluor	Fluor
Union—Calif.	Los Angeles, Calif.	Acid Treat. & Rerun;	15,000 bbls.	$1.7 million	Under Constr.	Aug., 1952		Braun	Braun
Union—Calif.	Los Angeles, Calif.	H_2S Recovery System		$340,000	Under Constr.	June, 1952		Girdler Corp.	
U. S. Navy and Standard Oil of Calif.	Elk Hills, Calif.	Nat. Gas Plt.	50 mmcf	$45 million	Planned	April, 1952			
FOREIGN									
Canada									
British-American	Moose Jaw, Sask.	Crude	15,000 bbls.						
British-American	Moose Jaw, Sask.	Thermal Crk.	1,500 bbls.	$8 million	Under Constr.	July, 1952	U.O.P.	Texas	Can. Kellogg
British-American	Moose Jaw, Sask.	Cat. Cracking	4,500 bbls.						
British-American Oil	Clarkson, Ont.	Grease plt.	42,000 lbs.	$1.5 million	Engineering	Late 1952		C. W. Nofsinger	
British American Oil and Shawinigan Chemicals	Montreal, East	Petro Chemical Plt.—Phenol	36,000 lbs.	$3 million	Under Constr.	Oct., 1952	Hercules	Can. Kellogg	Can. Kellogg
Cabot Carbon of Canada	Sarnia, Ont.	Carbon Black Plt.	54,000 lbs.	$1 million	Under Constr.	Early 1952		Stone & Webster	Stone & Webster
Canadian Chemical Co.	Edmonton Area, Alberta	Petro Chemical Plt.		$50 million	Under Constr.	Sept., 1952		Celanese-Brown Root	Brown Root
Canadian Oil Refineries	Proomfield, Ont.	Refinery	20,000 bbls.	$18 million	Under Constr.	April, 1952		Can. Kellogg	Can. Kellogg
*Canadian Industries	Montreal, Quebec	Plat. Unit	3800 bbls.		Under Constr.	1952	U.O.P	U.O.P.	Procon
		Polyethylene Mfg.		$13 million	Start Spring	Late 1953			
Celanese Corp.	Edmonton, Alta	Chemical Plt.		$40 million	Announced				
Dominion Tar & Chemical Co., Ltd.	Montreal East	Petro Chemical Plt.		$50 million	Design	End 1953		Badger	Badger
Imperial Oil	Edmonton, Alberta	Fluid Cat. Crk., Gas Recov. Plt. Vac. Dist. Unit	22,600 bbls.	$5.5 million	Under Constr.	Summer 1952		Staff	Foster Wheeler
Imperial Oil	Sarnia	Fluid Cat. Crk., Dist., Light Ends Recov.	71,000 bbls.	$14.6 million	Under Constr.	Summer 1953		Staff	Can. Kellogg

• CONTINUED ON PAGE 111

BRIDGEPORT BRASS COMPANY

CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND. — IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

PHYSICAL PROPERTIES OF COPPER AND RED BRASS TUBES

Although many copper alloys are available today for use in fresh water, copper itself is still most widely used in numerous types of heat exchangers, evaporators and condensers.

Copper is preferred to the yellow brasses because it does not contain zinc and hence is not subject to dezincification. It has the highest thermal conductivity of the common metals and is specified where this property is desirable. Since it does not become covered with an insulating layer of rust, the heat transfer properties are maintained in service.

Copper and copper alloys are not subject to embrittlement at low temperatures required in refrigerating and cooling operations. Copper and red brass are also resistant to the common organic refrigerants containing halogens such as Freon, etc. Copper is also satisfactory for handling dry sulphur dioxide but is not suitable for ammonia.

In ammonia refrigeration systems, copper (and red brass and other copper alloys) in combination with low carbon steel (Duplex Tubing) is fast replacing steel tubing. The fresh cooling water is handled on the copper side while ammonia comes in contact with the steel side. This combination of metals has the advantage of better heat transfer properties than steel tubing itself. Copper is less subject to fouling by algae and bacteria than steel. Where strength and corrosion resistance to flue gases are desired, Duplex Tubing with steel to the gases and copper towards the water side, is giving satisfactory results as compared with steel boiler tubes.

Copper is also widely used in low pressure feed water heaters and hot water heaters because of its good resistance to corrosion by steam, condensate, and water.

Arsenical copper is preferred where its service records indicate its superiority. In general the various grades of copper show essentially the same corrosion resistance.

Copper is widely used in sugar refining operations where traces of ammonia may lead to stress-corrosion cracking of the yellow brasses.

COMPARATIVE PHYSICAL AND MECHANICAL PROPERTIES OF DEOXIDIZED COPPER, ARSENICAL COPPER AND RED BRASS

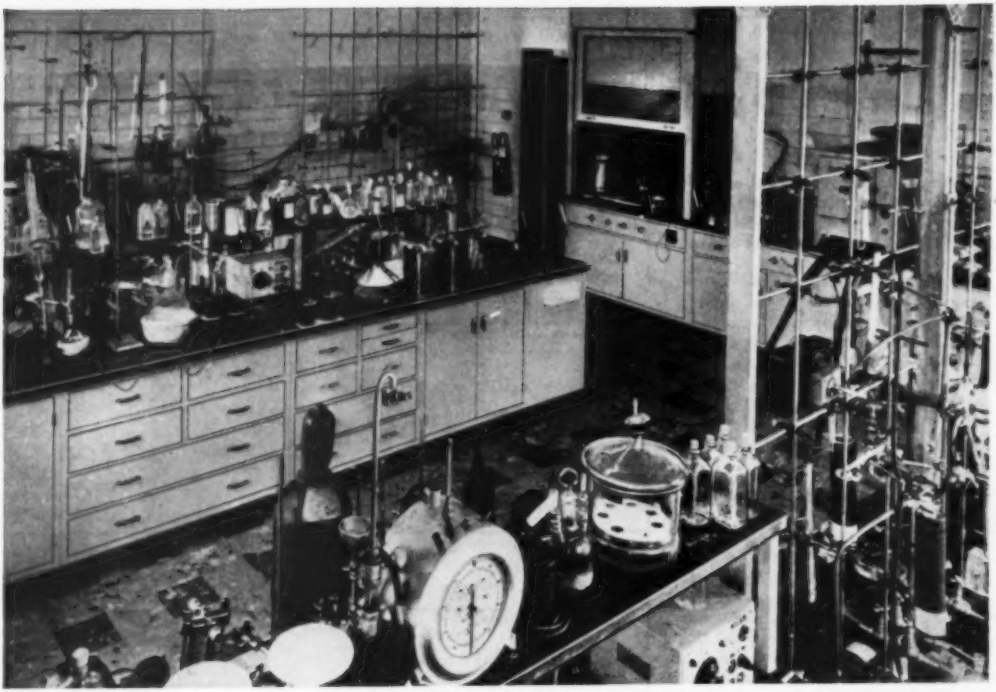
ANALYSIS	Deoxidized Copper 105	Arsenical Copper 108	Red Brass 85
Copper	99.9	99.4	85.0
Zinc			15.0
Phosphorus	0.02	0.02	
Arsenic		0.3	
MECHANICAL PROPERTIES			
Tensile Strength—Hard Drawn	45,000	45,000	—
—Light Drawn	37,000	37,000	—
—Soft	30,000	30,000	40,000
Yield Strength—Hard Drawn	40,000	40,000	—
—Light Drawn	30,000	30,000	—
—Soft	8,000	8,000	12,000
Elongation % in 2" Hard	25	20	—
Soft		47	45
Contraction in Area % Hard		48	—
Soft		62	76
Rockwell Hardness—Hard	F77	F77	—
—Soft	F40	F42	F71
Elastic Limit—Soft	9,000	9,000	15,000
Modulus of Elasticity in Tension x 10^6	17	16	15
PHYSICAL CONSTANTS			
Density @ 68°F lbs./cu. in.	0.323	0.323	0.316
Specific Gravity	8.94	8.89	8.75
Melting Pt. °F Liquidus	1981	1978	1880
Solidus	—	—	1810
THERMAL CONSTANTS			
Coefficients of Thermal Exp. per °F from 68°F to 572°F x 10^{-6}	9.8	9.8	10.4
per °C from 20°C to 300°C x 10^{-6}	17.7	17.7	18.7
Thermal Conductivity at 68°F BTU/sq. ft./ft./hr./°F	196	112	92
Calories/cm^2/cm/sec/°C	0.81	0.46	0.38
Thermal Capacity (spec. heat) @ 68°F BTU/lb./°F	0.092	0.092	0.09
@ 20°C cal./gm./°C	0.092	0.092	0.09
ELECTRICAL CONSTANTS			
Resistivity ohms/mil foot @ 68°F (annealed)	12.2	24	28
Conductivity % IACS @ 68°F (annealed)	85	45	37
(annealed) megmho-cm^3 @ 20°C	0.493	0.261	0.215
Resistivity, micro-ohm centimeters @ 20°C (annealed)	2.03	4	4.7
Color	Red	Red	Reddish
FABRICATION PROPERTIES			
Cold working	Excellent	Excellent	Excellent
Hot working	Excellent	Excellent	Good
Hot working Temp. °F	1400-1600	1400-1600	1450-1650
Hot working Temp. °C	750-875	750-850	800-900
Machinability rating	20	20	30
Soft soldering	Excellent	Excellent	Excellent
Silver brazing	Excellent	Excellent	Excellent
Oxyacetylene welding	Fair	Fair	Good
Carbon arc welding	Good	Good	Good
Resistance welding	Poor	Poor	Poor
Polishing	Good	Good	Good
Annealing Temp. °F	700-1200	900-1250	800-1350
SPECIFICATIONS			
A.S.T.M.	B-111-50	B-111-50	B-111-50
U. S. Navy			
Federal			

Red brass is superior to the yellow brasses as far as resistance to dezincification is concerned. It also has a somewhat higher heat conductivity than the yellow brasses but less than copper. In fresh waters, red brass and copper are often interchanged with satisfactory results.

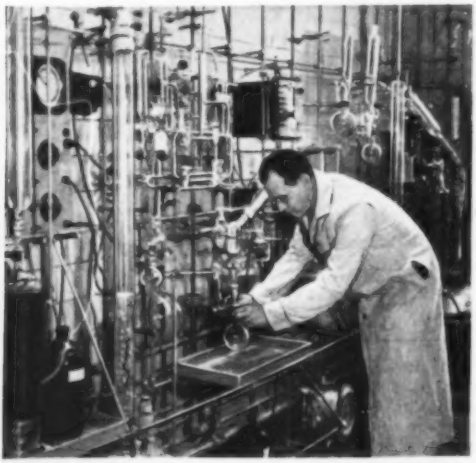
The accompanying table gives the physical and fabrication properties and specifications of Deoxidized Copper, Arsenical Copper and Red Brass, and should be helpful to design engineers.

Tensile and Yield Strength values meet minimum engineering requirements. (8141)

These Great Laboratory



PETROCHEMICALS offer independent inventors great opportunity for exploration and reward. Such synthetics as Nylon, Vinylite, Neolite are already indispensable to our expanding economy—and new ideas in this area are at a premium today.



UNDER THE SINCLAIR PLAN, chemistry laboratories like these are open for the first time to independent inventors.

ELECTRON MICROSCOPE, capable of magnifying 100,000 times, is typical of the expensive equipment now available.

Facilities Are Open to You

Many inventive people have responded to the Sinclair Plan's offer of laboratory facilities — to others who wish to do so, a suggestion: There is promise and profit in oil-based synthetics.

EIGHT months ago, Sinclair turned over a part of its great laboratories at Harvey, Illinois, to independent inventors who had promising ideas in the field of petroleum products but who did not have the facilities needed to develop or prove out their ideas.

To date nearly 5,000 people have submitted ideas to the laboratories, and the Plan is recognized as a valuable service to independent inventors. As a result we have made the Sinclair Plan part and parcel of the long-range operation of our company.

There may be inventive people interested in this Plan but wondering what sort of ideas or what areas would be profitable to explore. To those people we suggest the field of petrochemicals. Such things as plastics, synthetics, substitutes and new materials as yet undeveloped—made from petroleum—offer great opportunities for invention and reward.

If you have an idea of this sort—or in the general area of petroleum products or applications—you are invited to submit it to the Sinclair Research Laboratories. In your own interest, each idea must first be protected by a patent application or a patent.

The inventor's idea remains his own property

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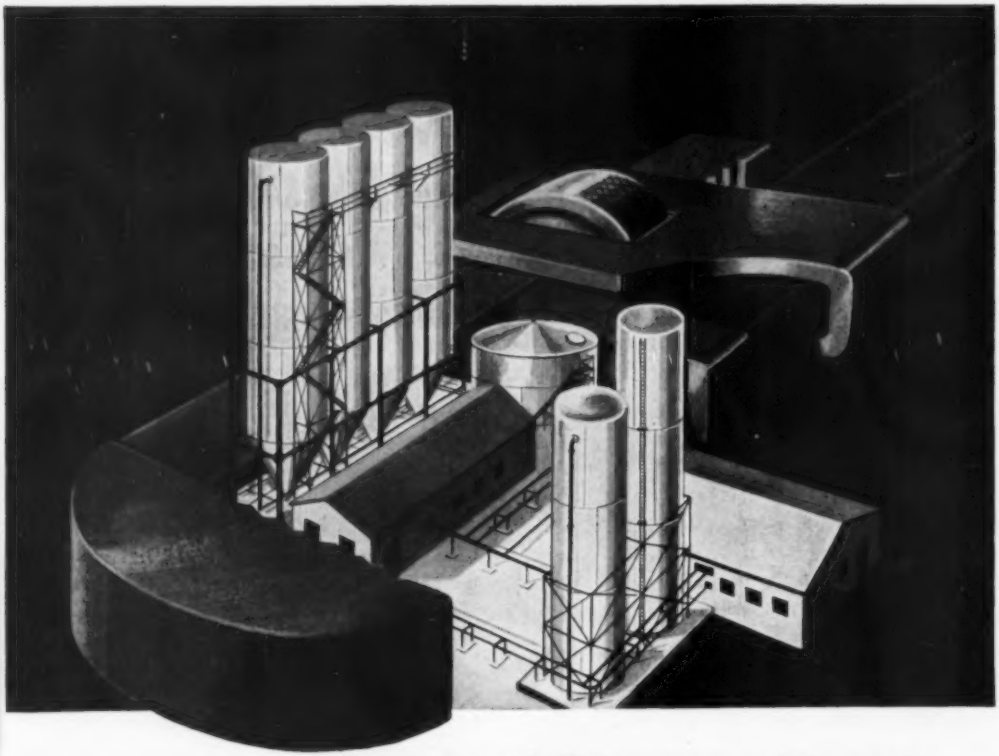

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Imperial Oil	Sarnia	30 Storage Tanks	3 million bbls.		Under Constr.	Summer 1952		Toronto Iron Works	Horton Steel
Imperial Oil	Ioco, B. C.	Cat Cracker Modernization & Expan.	†10,500 bbls. †2,500 bbls.	$13.5 million $7 million	Field Constr. Plan	Fall 1953 Early 1954		Staff Staff	Tenders out Tenders
*Imperial Oil	Regina, Sask.	Refinery		$12 million	Const. Soon				
*McColl-Frontenac	Winnipeg, Manitoba	Crude Refinery	4,000 bbls.	$2 million	Under Constr.			Procon	Procon
Midland Pet. & Pacific Pet.	Stettler, Alta.	Grease and Compounding			Projected				
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Sulfur Recovery	30 Long tons	$350,000	Under Constr.	April, 1953		Foster Wheeler	Foster Wheeler
Royalite Oil	Turner Valley, Calgary	Sulfur	33 tons	$500,000	Completed	Early, 1952			
Shell Oil	Jumping Pound, Alta.	Petro Chem Plt	50,000 lbs.	$3 million	Under Constr.	Late 1952			
Shell (Canada)	Montreal, East	Refinery Warehouse		$300,000					
Shell Oil	Sarnia, Ont.	Refinery	10,000 bbls.	$10 million	Spring, 1953	March, 1953	Houdry-Sun	Cat. Const.-Sun	Cat. Constr.
Sun Oil	Shellburn, Ver.	Asphalt Plt.			Planning				
Supreme Refineries	Ogden, Alta.								
Latin America									
*Brazilian Govt.	Sao Mateus (Santo) Brazil	Shale Oil Pilot Plt.	100 bpd	$500,000					
Brazilian Investments	Niteroy, Rde J. Brazil	Refinery	20,000 bbls.		Petitioned				Kellogg
*Cia Industrial de Rochas Betuminosas	Between Rio-Sao Paulo, Brazil	Shale oil pilot Plt.	20 bpd		Nearing Completion				
Conselho Nacional do Petroleo	Bahia, Brazil	Expansion	5,000 bbls.		Under Constr.			Kellogg	Kellogg
Conselho Nacional do Petroleo	Cubatao, Sao Paulo, Brazil	Therm. Crk. Ref. Reforming, Vis Breaking Cat. Poly	45,000 bbls.		Under Constr.	Mid, 1953		PA Hydro Res.	PA Hydro Res. and McKee
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Ref. Expn. Cat. Poly L.P.G., Plt.	2,500 bbls.	$3.5 million	Under Constr.	Sept., 1952		Kellogg	Kellogg
Conselho Nacional	Salvador, Brazil	Cat. Poly. LPG	5,000 bbls.		Under Constr.			Kellogg-P.A., Hydro. Res.	Staff
The Corporacion de Fomento de la Produccion	Concon, Valparaiso, Chile	Refinery	14,000 bbls.	$9 million	Planning	1953			
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring			Planning				
Creole Petroleum	Jusepin, Venezuela	Revamp Ref.			Under Constr.				Braun
Diadema, Argentina	Buenos Aires, Arg.	Luboil Refining	600 bbls.		Projected				
Empresa Nacional de Petroleo	Concon, Chile	Refinery	20,000 bbls.	$10 million	Begin 9-52			P.A., Kellogg	P.A., Kellogg
International Petroleum (Colombia)	Barrancabermeja, Colombia	Refinery Modernization	35,000 bbls.	$20-25 million	Under Constr.	Late 1954		Foster Wheeler	Foster Wheeler
Ipiranga S.A. Cia Brasileira de Petroleos	Rio Grande, Brasil	Therm. Crk. Ref.	2,000 bbls.		Authorized	1953	Foster Wheeler		
Monsanto S.A.	Sao Paulo, Brazil	Plastics Plt.			Under Constr.	Late 1952			
Petroleos Mexicanos	Mazatlan	Refinery	15,000 bbls.		Projected				
Petroleos Mexicanos	Ciudad Madero, Mexico	Desulfurization Units	12,000 bbls.	$1.5 million	Under Constr.		Perco	McKee-Phillips	McKee
Petroleos Mexicanos	Tamaulipas, Ciudad Madero, Mex.	Enlarge Refinery Capacity	47,250 bbls.		Planning				
Petroleos Mexicanos	Tamaulipas, Arbol Grande Pet., Mex.	Enlarge Refinery	16,000 bbls.		Planning				
Petroleos Mexicanos	Poza Rica, Mex	Desulfurization Units	3,000 bbls.	$400,000	Completed		Perco	Phillips	Staff
Petroleos Mexicanos	Mata Redonda, Vera Cruz, Mex.	Improvements	9,000 bbls.		Planning				
Petroleos Mexicanos	Poza Rica, Mex.	Improvements to Skimming Plant	3,100 bbls.		Planning				
Petroleos Mexicanos	Reynosa, Mex.	Expansion			Planning				
Petroleos Mexicanos	Salina Cruz, Mexico	Refinery			Planning				
Petroleos Mexicanos	Salamanca, Mex.	Lube Oil and Paraffin Plt.	2,500 bbls.	$20 million	Under Constr.	1954	Texaco	McKee	McKee
*Petroleos Mexicanos	Tampico, Mex.	Modern., Sulfur Ext.		$1.5 million		1952			
*Petroleos Mexicanos	Minatitlan, Mexico	Modern., Sulfur Ext.		$1.5 million		1953			
Phillips Oil Co.	San Roque Fld., Anzoategui, Venezuela	Refinery, Wax Plt.	2 mln. lbs. wax/year		Under Constr.	April, 1952		Pritchard	C. B. & I.
Phillips	San Roque Fld., Anzoategui, Venezuela	Crude Stab. and Pressure Maint. Plt.	10,000 bbls. and 38 mmc		Planning				
Phillips	San Roque	Crude Distill.	2,000 bbls.						
Private Group	Rio de Janeiro, Brazil	Refinery	20,000 bbls.						Kellogg
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	25,000 bbls.	$30 million	Projected		Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	
Refinaria de Petroleo do Districto Federal S.A.	Manguinhos, Brazil	Refinery	10,000 bbls.	$10 million	Contracted	Aug., 1952			
Refinaria de Petroleos do Distrito Federal S.A.	Rio de Janeiro, D. F. Brazil	Therm. Crk.	10,000 bbls.		Authorized			Foster Wheeler	Foster Wheeler
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref.	25,000 bbls.	$16.5 million	Under Constr.	End 1952	So-Vac.	P.A. Hydro. Res.	P. A. Hydro. Res.
*Reunidas F Materazzo	Sao Paulo, Brazil	Contact Sulfur Acid Plt.	60 tons		Ordered				Chemico
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.		Referred				
Shell Co. of Venezuela	Cardon, Ven.	Comprehensive Refg.	115,000 bbls.		Under Constr.	Early 1953			

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Trinidad Leaseholds, Ltd.	Trinidad	Refinery addition	.....	$300,000	Designing	.....	.....	H.W.P.	H.W.P.
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$54 million	Design	1951	.....	Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Gaso Treating	50,000 bbls.	$2.8 million	Under Constr.	1951	.....	Houdry, Cat. Constr.	Cat. Constr.
YPF Boliviano	Sucre, Polivia	Additional Unit	3,000 bbls	.....	Under Constr	1951	.....	.....	Foster Wheeler
Europe and Africa									
*AIOC	Nuehof, Germany	Refinery Expan.	4,000 bbls.	$2.8 million	.....	End 1952	.....	.....	.....
Anglo Iranian	Kent, England	Expansion	80,000 bbls.	.....	Under Constr.	1953	.....	Badger Div., Lummus, Kellogg	Badger Div., Lummus, Kellogg
Anglo-Iranian Oil	Isle of Grain, Eng.	New Refinery	40,000 bbls.	.....	Under Constr.	End, 1952	.....	Badger Div.	Badger Div.
Anglo-Iranian Oil	Kent, Eng.	Atmospheric Distill.	80,000 bbls.	.....	Contracted	60,000—1952 80,000—1953	.....	Badger Div.	Badger Div.
Anglo-Iranian Oil	Kent, England	Vacuum Distill.	2 x 17,000 bbls.	.....	Contracted	Mid 53 Fall 53	.....	.....	.....
Anglo-Iranian Oil	Kent, England	Rerun Unit	2,400 bbls.	.....	Under Constr.	.....	.....	.....	.....
Anglo-Iranian Oil	Kent, England	Solutizer	6,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
Anglo-Iranian Oil	Kent, England	Cu Chloride Treating	4 x 8,000 bbls.	.....	Under Constr.	.....	.....	.....	.....
Anglo-Iranian Oil	Kent, England	Acid/Soda Treat.	2,400 bbls.	.....	Under Constr.	.....	.....	Kellogg	Kellogg
Anglo-Iranian Oil	Kent, England	Propane Deasph.		.....	Engineering	.....	.....	Lummus	Lummus
Anglo-Iranian Oil	Kent, England	Furfural Extrac	2,800 bbls.	.....	Engineering	Fall	.....	Foster Wheeler	Foster Wheeler
Anglo-Iranian Oil	Kent, England	MEK Dewaxing		.....	Engineering	1953	.....	Lummus	Lummus
Anglo-Iranian Oil	Kent, England	Clay Contact		.....	Engineering	.....	.....	Kellogg	Kellogg
Anglo-Iranian Oil	Kent, England	Fluid Cat. Crk.	10,000 bbls.	.....	Start 1952	Mid 1953	.....	Hydro. Res.	.....
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plt.	.....	$50-60 million	Contracted	.....	.....	.....	.....
Aquila, S.A.	Trieste, Italy	Prop. Deasph., Furf. Sol. Ref. MEK Dewax. Contact Filtr. Dist. & Blending Plt.	100 tons 95 U1 Lubes & Bright Stocks 8 tons all Paraffin Waxes	$7.9 million	Under Constr.	.....	Juik, Texaco	Badger Div.	Badger Div.
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	800 bbls	$7.9 million	Under Constr.	.....	Juik, Texaco	Badger Div.	Badger Div.
Azienda Generale Italiana Petroli	Cortemaggiore Field, Italy	Gasoline Extraction Plt.	105 mmcf	$2.5 million	Completed	.....	.....	Pritchard & Co.	North American Pet. Gas Corp.
Benzene & Pet. Co. of Hamburg	Hamburg-Finken, Werder, Germany	Expansion	660,000 bbls.	.....	Announced	.....	.....	.....	.....
William Briggs & Sons, Ltd.	Camperdown, Scotland	Crude Dist. Fac.	1,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
California-Texas Oil Co.	Pernis, Netherlands	Expanding Refinery	28,000 bbls.	.....	Under Constr.	Early 1953	.....	Various Local	Various Local
Cie de Raffinage Shell-Berre	Berre, France	Expansion	65,000 bbls.	$31.6 million	Under Constr.	End 1953	.....	.....	.....
Cie de Raff Shell-Berre	Pauillac, France	Distilling Expansion	10,800 bbls.	.....	Under Constr.	Late 1952	.....	.....	.....
Cie Francaise de Raffinage	La Mede, France	Cat. Crk., Gas Recov. System	11,500 bbls.	$10 million	Authorized	1953	.....	.....	.....
Cie Francaise de Raffinage	Gonfreville, France	Gas Recov. System							
Cie. Francaise de Raffinage	Gonfreville, France	Therm. Reform., Prop. Deasp., Furf. Trtng.	4,750 bbls	$11 million	Under Constr	1952	Texaco & Juik	Kellogg	Local
C.E.P.S.A.	Santa Cruz de Tenerife	Reforming Unit	6,000 bbls.	$1 million	Planned	.....	U.O.P.	U.O.P.	Foster Wheeler
Condor, S.P.A. Per l'Industriale Pet. Chemica	Rho, Italy	New Refinery	27,000 bbls.	.....	Under Constr.	1952	.....	Badger Div.	Badger Div.
Condor	Rho, Italy	Cat. Cracker	†15,000 bbls.	.....	Under Constr.	1952	.....	Badger Div.	Badger Div.
Condor	Rho, Italy	Atm. Dist. Plt.	30,000 bbls.	.....	Under Constr.	1952	.....	Badger Div.	Badger Div.
Condor	Rho, Italy	Feed Prep., TCC Unit	15,000 bbls. 10,000 bbls	.....	Under Constr.	.....	Socony-Vac.	Badger Div.	Badger Div.
Condor	Rho, Italy	Recov. Purification Plt., Adm. Bldg., Pwr. House	.....	.....	Under Constr.	1952	.....	Badger Div.	Badger Div.
Deutsche-Amerikanische Petro-Gesellschaft (Esso)	Hamberg-Harburg, Germany	Cracking Plt and Expansion	8,843 bbls.	$10 million	Under Constr.	Jan., 1954	.....	SOD	Gutte-Hutte
Deutsche Erdoel, A. G.	Heide, Germany	Cracking Fac.	†2,800 bbls. Gas †1,250 bbls. Diese	.....	.....	.....	.....	.....	.....
Deutsche Vacuum Oel A.G.	Hamburg, Germany	Cracking Unit	8,000 bbls.	.....	Under Constr.	Sept., 1952	.....	Socony-Vac.	Hutte
Egyptian Government	Cairo, Egypt	Crude Plt.	.....	$2,500,000	Planning	.....	.....	Lummus	Lummus
Egyptian Government	Suez, Egypt	Inc. Refn. Cap.	26,000 bbls.	.....	Under Constr.	1952	.....	.....	Lummus
Empresa Nacional	Puertollano, Spain	Shale Oil Ref.	3,000 bbls.	.....	Under Constr.	July, 1953	.....	S. O. D.	Lummus
Esso Standard Refg.	Antwerp, Belg.	New Refinery Incl. Crker.	25,000 bbls.	$8,670,000	Under Constr.	4th Qtr., 1952	Houdry	Lummus	Lummus
Gewerkschaft Erdoel-Raffinerie Emsland	Near Lingen, Germany	Refinery Houdry Cat.	11,535 bbls. 7,000 bbls.	.....	Contracted	Aug., 1952	.....	Koch	Staff
Industrie Chimiche Italiane Petroli	Mantau, Italy	Crude Ref.	4,500 bbls.	.....	.....	.....	.....	Dr. Calogero Ingiogin	.....
Industria Petrolifera Chimica	Milan, Italy	Gasoline Fuel Oil Plt.	20,000 bbls.	$2 million	Under Constr.	.....	.....	Foster Wheeler	Kellogg
Industrie Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Cat. Cracking Atmos. Distill. Thermal Ref.	1,400 bbls. 12,000 bbls. 6,000 bbls.	.....	Under Constr.	.....	.....	Kellogg	Kellogg
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit	2,000 bbls.	.....	Under Constr.	Jan., 1952	Phillips So-Vac.	Koch	Staff
I. P. S. A.	Rotkreuz, Switz	Cat. Reformer	700 bbls.	.....	Licensed	.....	.....	.....	.....
*Kali Chemie Co.	Nienberg, Germany	Bead Catalyst Plt.	.....	.....	Under Constr.	Early 1953	.....	.....	Am. Cynamid
*Ketjen	Amsterdam, Netherlands	Synthetic Catalyst & Mfg.	.....	.....	Projected	.....	.....	.....	.....
Manchester Oil Refinery, Ltd.	Partington, England	New Lube Refinery	30,000 bbls.	.....	Under Constr.	End 1952	.....	.....	.....
Manchester Oil Refinery	Trafford Park, Eng.	Expansion	.....	.....	.....	.....	.....	.....	.....
Mineraloel-und Asphaltwerke, A.G.	Ostermoor, Germany	Reconstruction	1,196 bbls.	.....	.....	.....	.....	.....	.....
Monsanto Chemical Co.	Britain	Add Polystyrene	.....	.....	Under Constr.	.....	.....	Staff	Staff
Montecatini Co.	Ferrara, Italy	Olefin Plt.	450 bbls.	$18.6 million	Contracted	Mid 1953	.....	Kellogg	Kellogg
A. P. Moeller	Copenhagen, Denmark	Thermal Cracking Plt.	2,000 bbls.	$3.5 million	Field work	.....	.....	.....	.....
National Oil Refineries, Ltd	Llandarcy, Wales	Vacuum Unit	17,000 bbls.	.....	Under Constr.	.....	.....	Badger Div.	Badger Div.

• CONTINUED ON PAGE 115

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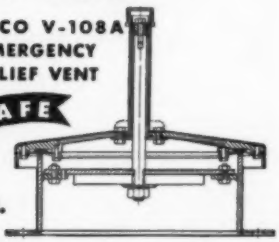

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REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

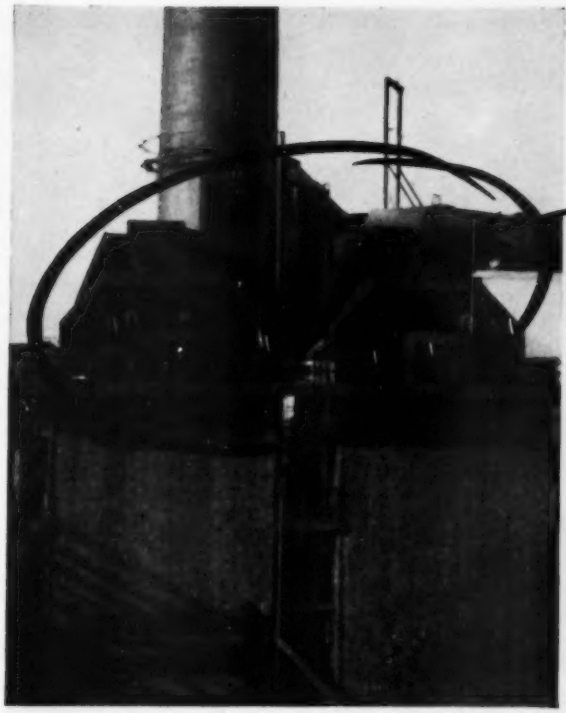
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Not Known	Sidi Aissa, Fr N. Africa	Refinery (Topping plt.)	225 bbls.		Completed				Austrian Co.
N.O.R.	Llandarcy	Propane Desasphalting	3,500 bbls.		Under Constr.	End, 1952	J.U.I.K.	Badger Div.	Badger Div.
N.O.R.	Llandarcy	Furf. Ext.	1,280 bbls.		Under Constr.	End, 1952	Texaco	Badger Div.	Badger Div.
N.O.R.	Llandarcy	M.E.K. Dewaxing	1,700 bbls.		Under Constr.	End, 1952	Texaco	Badger Div.	Badger Div.
N.O.R.	Llandarcy	80's Kerosene Ext.	3,000 bbls		Under Constr			H.W.P.	Staff
National Oil Refineries, Ltd.	Llandarcy, Wales	Additional Boilers			Under Constr.	1953		Ewbank & Partners	
N.O.R.	Llandarcy	Generating Plant	13,000 KW		Authorized	1953		Ewbank & Partners	
N.O.R.	Llandarcy	Cat. Crk.	10,000 bbls.	$48 million	Under Constr.	Early 1953		Kellogg	Kellogg
A/S Norsk Amerikansk Mineraloljekompagni	Vallo, near Tonberg, Norway	Lubs Oil, Asphalt	1,000 bbls.						
Poehelbrona, S.A. E. M.	Merkwiller, France	Capacity Increase	1,580 bbls.		Authorized				
Permolio, S.P.A., Raffinerie Italiane Olii Minerali	Genoa, Italy	TCC Unit	2,000 bbls.	$1.4 million	Under Constr.	March, 1952	Socony-Vac.	Foster Wheeler	Foster Wheeler
Permolio, S.P.A.	Milan, Italy	Perco Reforming Unit	350 bbls.		Engineering	1952	Phillips		
Permolio, S.P.A.	Rome, Italy	TCC Unit	2,000 bbls.	$1.4 million	Under Constr.	March, 1952	Socony-Vac.	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	Furf. Sol. Ref.			Planning	1952	Stand-Tex.	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	Prop. Desasph.	15,000 tons/yr.		Planning	1952	Stand-Tex.	Foster Wheeler	Foster Wheeler
Permolio	Milan, Italy	MEK Dewax.			Planning	1952	Stand-Tex	Foster Wheeler	Foster Wheeler
Petrochemicals, Ltd.	Partington, England	Petrochemicals	2,000 bbls.	$16 million	Under Constr.		Petrocarbon	Petrocarbon	Petrocarbon
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million				Separator-Nobel	
Raffineries Francaises	Paris	Thermal Reformer	4,800 bbls.		Under Constr.	Jan., 1952		Koch	Koch
Raffinerie Siciliane Olii Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.		Under Constr.		U.O.P.	U.O.P., Delta, Staff, Separator-Noble	Staff
Refineria de Petroleos de Escombreras, SA., (REPESA)	Escombreras Spain	Four cell induced draft cooling tower			Under Contract				Foster Wheeler
REPESA	Escombreras, Spain	Crude Dist.	23,000 bbls.	$30 million	Under Constr.	Mid 1953		Foster Wheeler	Foster Wheeler
REPESA	Escombreras	Thermal Reformer: Poly Cat.	6,200 bbls.	$2 million	Contracted	Fall, 1952	U.O.P.	McKee	Staff
Ruhrchemie, A.G.	Oberhausen-Holten, Germ.	Crude Refinery	6,000 bbls.		Under Constr.	Mid 1952		Koch	Koch
S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Topping Unit	10,000 bbls.						
S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Cracking Unit	5,000 bbls.						
S.A. Conc. Ref. Pet. em Portugal	Cabo Riuvo Plt., Portugal	Reformer	2,800 bbls.						
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Gas Rec. Vac. Distill., Cat. Poly Plt., & Trting. Plt.	37,700 bbls.	$52 million	Under Constr.	Mid., 1952			
Shell Chemical Mfg. Co., Ltd.	Stanlow, Eng.	Teepol Plant Extension	75,000 tons per year		Under Constr.	Spring, 1952			
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Reforming Unit	†10,000 bbls.		Under Constr.	Early 1952			
Shell R. & M.	Shell Haven, England	Feed Prep.	†16,000 bbls.	$34 million	Under Constr.	Early 1952			
Shell R. & M.	Stanlow, Eng.	Comprehensive Refining	85,000 bbls.		Under Constr.	Early 1952			
Soc. Raff Petrole Gironde	d'Amben, France	Capacity Expan.	16,500 bbls.		Under Constr.	Mid 1952			
Societa per l'Industria del Petrolio	La Spezia, Italy	Expansion	30,000 bbls.		Under Constr.	Early 1953			
Societa per Azioni Raffineria Padana Olii Minerali	Milan, Italy	Refinery	10,000 bbls	$30 million	Planned				
Societe per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	13,300 bbls.	$15 million	Under Constr.	Sept., 1952		Badger Div.	Badger Div.
Societa Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load Facilities	11,600 bbls.	$6.4 million	Contracted				
Socony-Vacuum Francaise	Frontignan, France	T.C.C. Unit	15,000 bbls.		Completed		Socony-Vac.		
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	$6 million	Under Constr.		Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	900 lbs.		Under Constr.			Staff	Staff
Socony-Vacuum Italiana, S.P.A.	Naples, Italy	Visbreaker						Staff	Staff
South Africa Coal Oil & Gas	Coalbrook, Orange Free St.	Plant	3,500 bbls.	$50.4 million	Under Constr.	1955		Kellogg	Kellogg
Stanic Industria Petrolifera	Leghorn, Italy	Ref. Expan.	15,500 bbls.		Under Constr.	Mid 1953		Staff	Staff
Standard Francaise des Petroles	Port Jerome, France	Coal Synthesis Dewaxing Plant	1,200 bbls.	$6.4 million	Completed			S.O.D.	Foster Wheeler
Standard Francaise des Petroles	Port Jerome, France	Desasphalting Plant	1,800 bbls.		Completed			S.O.D.	
Standard Francaise des Petroles	Port Jerome, France	Cat. Crk. and Modernization	46,400 bbls.	$10 million	Under Constr.	June, 1953		SOD	Foster Wheeler
Standard Oil (N.J.)	Belgium	Dist. Crack	33,000 bbls		Planned	Early 1952			
*Standard (N.J.)	Hamburg, Germany	General Expan.	32,000 bbls.	$10 million	Plan	Jan., 1954		SOD	Gutehoffnung-Schutte
Standard-Vacuum Ref. of South Africa	Wentworth, Durban, Union of S. Africa	Refinery	15,000 bbls.	$17 million	Begin 5/52	Late 1953		Foster Wheeler	Foster Wheeler
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved				

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$20 million	Projected	.....	.....	.....	.....
Vacuum Oil Co., Ltd.	London, Eng.	Oil Refinery	63 mln. bbls./yr.	$28 million	Planning	.....	.....	.....	.....
Vacuum Oil Co., Ltd.	Birkenhead, England	Grease Plt.	.....	$1 million	Contracted	Early 1952	.....	H.W.P.	H.W.P.
Vacuum Oil Co.	Coryton, Eng.	Lube Refinery	17,000 bbls.	$30 million	Under Constr.	Jan., 1953	.....	Lummus	Foster Wheeler
Near East									
*Anglo-Iranian	Aden, Saudi Arabia	New Refinery	103,000 bbls.	.....	Projected	.....	.....	.....	.....
*Bahrein Pet.	Bahrein	Modern. Fluid	26,000 bbls.	.....	Under Constr.	Early 1953	.....	.....	Staff
Caltex	Sidon, Lebanon	Diesel, Fuel Oil Plt.	13,000 bbls.	$5.8 million	Plan	Fall, 1953	.....	Badger Div.	.....
Consolidated Ref., Ltd.	Haifa, Palestine	Gen. Facilities Conversion of Kellogg Comb. Top. and Crk.	35,000 bbls.	.....	Planned	.....	.....	Kellogg	Kellogg
Iraq Government	Baghdad Area	Refinery	24,000 bbls.	$25.2 million	Contracted	Spring, 1954	.....	.....	Staff
Israeli Government	Haifa, Palestine	Petro Chem Plt.	10 tons	$2.8 million	Under Constr.	.....	.....	.....	.....
Turkey Government	Ramandag Field	Refinery	3,000 bbls.	$3.5 million	Planning	.....	.....	.....	.....
Far East									
Batavische Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	44,000 bbls.	.....	Under Constr.	Mid 1953	.....	.....	.....
Batavische Pet. Mij.	Pladjoe, Sumatra	Rehad. to Comprehensive Refg.	71,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Batavische Pet. Mij.	Tjepu, Java	Rebuild TEL Blending Unit & Dist. Unit	.....	.....	Planning	.....	.....	.....	.....
Burmah Oil Co., Ltd.	Syriam, Burma	Furf. Sol. Dewax., Wax Mfg.	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger Div.	.....
Burmah Oil (Rangoon)	Chaukfield, Burma	2 Stage Distillation & Related Fac.	3,000 bbls.	Salvage	Under Constr.	Dec., 1952	.....	Staff	Staff
Burmah Shell	Bombay, India	Refinery	30,000 bbls.	$47 million	Agreed	1956	.....	.....	.....
*Burmah-Shell	Bombay, India	.....	38,000 bbls.	$47 million	Plan	Early 1956	.....	.....	.....
*Caltex	India	.....	20,000 bbls.	.....	Plan	.....	.....	.....	.....
Caltex	Visagapatam, India	Refinery	.....	.....	Expected	.....	.....	.....	.....
N. V. Curacaosche Petroleum	Curacao Netherlands, Antilles	Lube Ref. Ext.	2,000 bbls.	.....	Projected	Early 1954	.....	.....	.....
KOA Oil Co., Ltd. (and)	Marifu, Japan	Expansion of Vac. Unit, Contact Rerun Unit	Restricted to 3,000 BPCD	.....	Under Constr.	.....	.....	Tatsumi	Tatsumi
Caltex Oil Co., Ltd.	India	2 Coal Hydrogenation Plts.	70,000 tons	.....	Announced	.....	.....	.....	.....
*Koppers Co.									
Koa Oil Co., Ltd.	Marifu, Japan	Modern. Plat.	10,000 bbls.	.....	Under Constr.	April, 1952	.....	.....	.....
			1,300 bbls.		Engineering	Oct., 1953			
Mitsubish Oil Co., Ltd.	Tokyo, Japan	Vacuum Distillation Unit	2,000 bbls.	.....	.....	.....	.....	.....	.....
Mitsubishi Oil	Tokyo, Japan	Solvent Extraction & Dewaxing Processes	.....	.....	.....	.....	.....	.....	.....
Nippon Oil Co., Ltd.	Yokohama, Japan	Modern. and Expansion	12,000 bbls.	.....	Under Constr.	July, 1954	.....	.....	.....
Nippon Oil	Kudamatsu, Japan	Modern. Plat. Unit	7,000 bbls.	.....	Under Constr.	End 1952	.....	.....	.....
			1,300 bbls.		Engineering	Oct., 1953			
Nippon Oil	Japan	Lube Oil Refining	.....	.....	Under Constr.	.....	.....	Separator-Noble	.....
*Standard-Vacuum	Bombay, India	Refinery	19,000 bbls.	$35 million	Agreed	1956	.....	.....	.....
*Stan-Vac	Bombay, India	.....	20,000 bbls.	$35 million	Plan	.....	.....	.....	.....
Toa Nenryo Kogyo K. K.	Wakayama, Japan	Propane, Dewaxing	1,200 bbls.	.....	Under Constr.	Oct., 1952	.....	S.O.D.-Staff	Staff
T. N. K.	Wakayama	Phenol Ext.	1,720 bbls.	.....	Under Constr.	Oct., 1952	.....	S.O.D.-Staff	Staff
Oceania									
†AIOC	Fremantle, Australia	Refinery	58,000 bbls.	$112 million	Planned	.....	.....	.....	.....
*Anglo-Iranian	Victoria, Australia	Refinery or Expansion	55-85,000 bbls.	$66-90 million	Considering	.....	.....	.....	.....
Australian Shell	Clyde, New South Wales	LVI Lube Oil	250 bbls.	$630,000	Under Constr.	Sept., 1952	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	26,000 bbls.	$12 million	Under Consid.	Late 1954	.....	.....	.....
Australian Shell	Geelong, Victoria, Australia	Bitumen and Laboil Plant	.....	$10 million	Projected	Late 1953	.....	.....	.....
Australian Shell	Geelong, Victoria, Australia	Asphalt, Lube Sol. Ketex Plt.	.....	.....	Projected	Late 1953	.....	.....	.....
Australian Shell	Melbourne, Australia	New Refinery	22,000 bbls.	.....	Under Constr.	Fall, 1953	.....	.....	.....
*Bitumen & Oil Ref.	Matraville (NSW) Aust.	Platforming Unit	1,500 bbls.	.....	Under Constr.	Mid 1952	.....	.....	.....
*Caltex	Sydney, Australia	Refinery	22,000 bbls.	$56 million	Engineering	Jan., 1955	.....	.....	.....
*Caltex	Manila, P.I.	Refinery	13,000 bbls.	.....	Engineering	July, 1954	.....	.....	.....
*Vacuum Oil Co.	Altona, Aust.	Refinery	20,000 bbls.	$30 million	Planned	1955	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE: Austin—Austin Co. Badger Div.—Stone & Webster Engineering Co. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Blaw-Knox—Blaw-Knox Construction Co. Braun—C. F. Braun Co. Breda—Breda Co. of Milam. Brown & Root—Brown & Root Construction Co. Cabot Eng.—Cabot Engineering. Can. Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B. & I.—Chicago Bridge & Iron Works Co. Consd. Eng.—Consolidated Engineering Co. D&Z—Day & Zimmerman. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. Ebasco—Ebasco Services, Inc. E & A—Ehrhart & Arthur, Inc. Esso Eng.—Esso Engineering Corp. Ferguson—H. K. Ferguson Co. Fletcher—Fletcher Oil Co. Fluor—Fluor Corp. Graff—Graff Engineering & Equipment Co. Grebe & Doremus—Grebe & Doremus Process Co. Gutte-Hutte—Gutte Hofnungs Hutte. Hercules—Hercules Powder Co. Huber—J. M. Huber Corp. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Process, Ltd. Hydrocarbon—Hydrocarbon Research, Inc. J.& L.—Jones & Laughlin Supply Co. Kellogg—The M. W. Kellogg Co. Kellogg P.A.—Kellogg Pan-American. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Lummus—The Lummus Co. McKee—Arthur G. McKee Co. O. L. Olson. P. A. Hydro Res.—Pan American Hydrocarbon Research Co. Parker—Parker, Steffens & Pearce. Parsons—The Ralph M. Parsons Co. Perco—Div. Phillips Petroleum. Petco—Petroleum Engineering Tool Co. Petrocarbon—Petrocarbon, Ltd. Phillips—Phillips Petroleum Co. Pioneer—Pioneer Industrial Co. Pritchard—J. H. Pritchard Co. Procon—Process Construction, Inc. Pro. Eng.—Process Engineers, Inc. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Schneider—Schneider & Cie. Socony-Vac.—Socony-Vacuum Oil Co. SOD—Standard Oil Development Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Sunland—Sunland Refining Co. Sweco—Southwestern Engineering Co. Tatsumi—Tatsumi Engineering Co. Tears—Tears Engineers. Tellepsen—Tellepsen Construction Co. Texaco—The Texas Co. UOP—Universal Oil Products Co. Walker—P. J. Walker Co.



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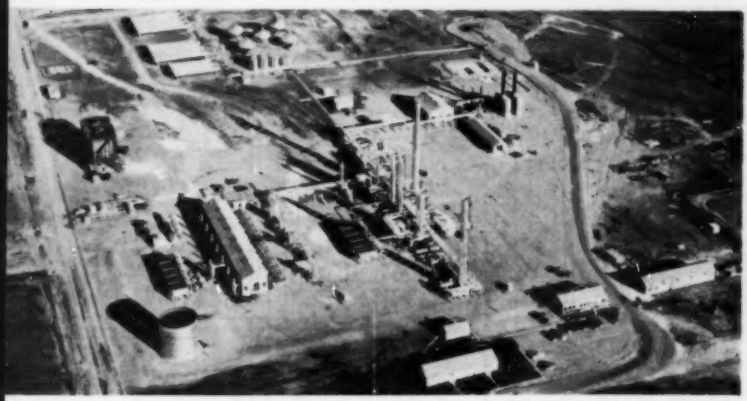


Airview of Snyder Gasoline Plant, Located near Snyder, Scurry County, in West Texas.

Modern and Unique Designs Featured in Snyder Gasoline Plant

W. F. CHAPIN

The Fluor Corporation, Ltd., Houston

HIGHLIGHTING natural gasoline developments in 1951, the Snyder gasoline plant, operated by Sunray Oil Corporation for some 30 companies and 60 individuals, contains some of the most modern and unique design features ever employed in natural gasoline plant practice. The most outstanding single feature is the deethanizing absorber. This one column is the heart of the plant, which is reportedly the largest natural gasoline plant in existence in terms of liquid production.

AS THE heart of the Snyder gasoline plant, the deethanizing absorber merits initial consideration in describing the unique design of this installation. This 145-ton absorber, operating at 500 psig., contains 50 trays, 24 in the absorption section and 26 in the stripping section. The column is 96 inches i.d. from the top down through tray No. 34 and 102 inches i.d. below that point. The feed stream, gas and its equilibrium condensate, from the third stage gas coolers enters the column between the above two sections. Lean oil is circulated to the top of the absorption section. Stripping vapor is derived from a kettle type reboiler at the bottom of the stripping section. Residue gas leaves the top of the column while the bottom product is a deethanized rich oil that need only be separated into its desired portions.

Because of the separation made in this column no further reabsorption or processing of the rich oil is required, other than to remove the absorbed raw gasoline from the lean oil in the still. And as the rich oil has been deethanized, total condensation of raw gasoline overhead product from the still is realized, with no recompression required or any resultant plant recycle streams involved. This obviously reduces installed equipment required and simplifies plant operation and maintenance considerably.

Historically the method of combined absorption and deethanization in one column originated in refinery practice where gas streams are normally rich but usually available at pressures not exceeding 200-250 pounds. In these cases the column bottom temperatures range up to 400° F. Time and increased technological knowledge eventually transposed these principles into natural gasoline plant usage. However, because of the comparative leanness of the usual feed gas streams to gasoline plants, this principle was applied to a combined reabsorption-deethanization step, resulting in the now common rich oil deethanizer.[1,2] The leaner gas prevented the application of this method on primary absorption as done in refinery practice because of the consequent relatively high temperature required.

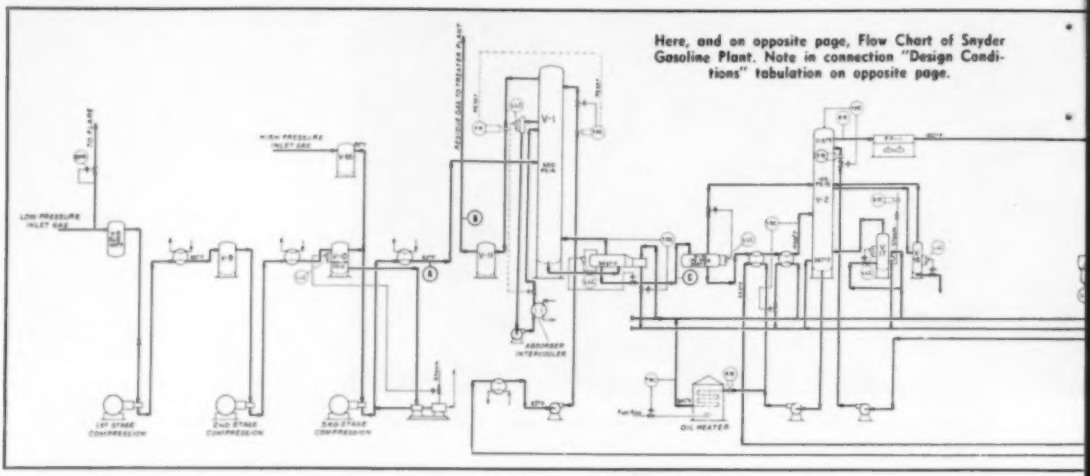
The design analysis of the gas for the Snyder gasoline plant was exceptionally rich. Therefore, a deethanizing absorber definitely invited serious consideration for the design of the plant. Rigorous calculations showed the complete feasibility of proposing such a process scheme. Although, to the best of the writer's knowledge, this type of plant had never heretofore been applied to natural gasoline plant practice and never in any event at an operating pressure as high as 500 psig, the required operating conditions for this absorber were within the known range of proved equilibrium and thermodynamic data.

Field System

The Snyder Gasoline Plant Advisory Committee the plant and field "governing body," includes representatives from Sunray Oil Corporation (operators for the project), Fullerton Oil Company, Cities Service Oil Company, Skelly Oil Company, Scurry Natural Gasoline Corp., Lone Star Producing Company and L. M. Lockhart.

Gas is gathered and delivered to the plant through approximately 140 miles of low-pressure gathering system and 90 miles of a High-pressure gathering system. Some 850 wells in the Kelly-Snyder field feed into the gathering systems.[3]

The original design capacity for the plant was 50,000 Mscf per day with 70 percent propane recovery. However, certain equipment and piping in the gas handling facilities, both feed and residue, were sized to handle 67,500 Mscf per day of field gas to the plant. In addition, certain other equipment, such as the still, depropanizer and debutanizer, were designed to handle increased future plant production rates. Most design figures mentioned hereafter, however, are on the basis of 50,000 Mscf per day of field gas to the plant.



Here, and on opposite page, Flow Chart of Snyder Gasoline Plant. Note in connection "Design Conditions" tabulation on opposite page.

Compressors

The original compressors for the plant were purchased as seven 1100-hp, 2-cycle, V-type gas engine units. As it became apparent that gas handling capacity would have to be increased before completion of the job these compressors were supercharged to 1350-hp. These units are comprised of five compressor cylinders; two each on the first and third stages and one compressor cylinder on the second stage. The compressor cylinders and unloading equipment have been sized for a wide range of operating conditions. They are able to handle all low-pressure gas from the low-pressure gas gathering system only, or may have gas from the high-pressure system injected at the third stage suction so that the third stage handling capacity is approximately 320 percent of the first two stages. This permits wide flexibility in adjusting the respective quantities of gas from each of the two gathering systems. For example, 41,000 Mscf per day of low-pressure gas could be handled through all three stages with no interstage injection of high pressure gas, or the compressors could be operated to handle approximately 23,000 Mscf per day of gas from the low-pressure system and approximately 47,000 Mscf per day from the high-pressure system by injecting at the third stage at approximately 150 psig. These capacities are based on 0 psig first stage suction pressure, whereas this might range up to 10 psig with a corresponding capacity increase.

The first and second stage discharge gases are cooled to 90° F. by shell and tube coolers. Although no appreciable condensate results at the first stage discharge the significant quantity of condensate from the second stage discharge is pumped from the scrubber at this point to the inlet of the third stage gas coolers to aid condensation of the absorber feed.

Pulsation Dampening

One unique design feature is the inclusion of an integral patented pulsation-dampening system in the compressor piping, a system designed essentially to eliminate pulsation peaks which are inherent with reciprocating-type compressors. The design includes the compressor bottles, both suction and discharge, and the laterals and headers. The headers are split into secondary surge bottles by placing orifices at certain places. In addition to reducing mechanical vibration and pulsation to an absolute minimum, the dampening system permits the use of smaller line sizes than would be required in conventional compressor piping.

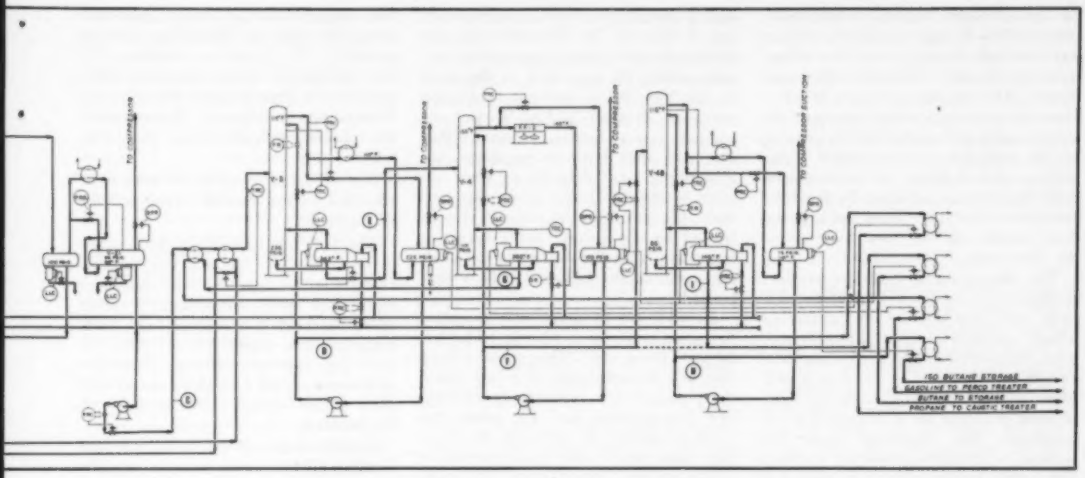
All the engine cooling requirements are accomplished with air cooling. A multi-cell fin-fan unit cools all water required for both engine jacket cooling and lube oil cooling. Each cell contains two finned sections for the former duty and one for the latter. Each of the systems is a conventional closed system with its pumps and surge tank, although the pumps used are in tandem for each service.

A further increase in the quantity of low-pressure gas from the field with a decrease of high-pressure gas has resulted in the recent addition and operation of two more compressors, making a total of nine. Present plans of the Advisory Committee call for installation of three more compressors at the plant.

The combined gas enters the third stage gas coolers which are designed to cool the effluent from this service to 82° F. Because any additional condensation at this point reduces the load on the absorber, design economics indicated an advantage in a close approach to available cooling water temperature. For actul plant design conditions the effluent from the third stage gas cooler is approximately 27½ percent condensed. The condensate is not separated from the gas at this point but the entire two-phase mixture flows to the feed point of the absorber from the gas coolers.

As previously described, lean oil is circulated to the top of the absorber and down through the absorption section. Rich oil from the twelfth tray of this section is removed from the column, pumped through an intercooler to remove a sizeable portion of the heat of absorption and returned to the thirteenth tray of the absorber. Rich oil from the bottom absorption tray (Tray 24) joins with the liquid portion of the feed stream and flows on to the top stripping tray (Tray 25). The vapor portion of the feed and the vapor from the stripping section passes up through the absorption section of the column. Rich oil from the stripping section bottom tray (Absorber Tray 50) passes to a kettle type reboiler which serves to supply the required stripping vapor to the column. The liquid from the absorber reboiler which has then been deethanized flows on for further processing.

Water draw-off pots remove water



Design Conditions—Snyder Gasoline Plant

STREAM	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
Description	Composite Inlet Gas[1]	Absorber Residue Gas	Absorber Bottoms[2]	Depropanized Ovhd. Product	Depropanizer Bottoms	Debutanizer Ovhd. Product	Debutanizer Bottoms[3]	Butane Splitter Ovhd. Product	Butane Splitter Bottoms
Composition Mol. Percent									
N_2	7.49	10.40	.....	.....	.....	.....	.....	.....	.....
CO_2	0.37	0.51	.....	.....	.....	.....	.....	.....	.....
C_1	39.98	55.52	.....	.....	.....	.....	.....	.....	.....
C_2	18.64	25.36	1.33	2.62	.....	.....	.....	.....	.....
C_3	19.40	8.08	48.54	95.20	0.40	0.60	.....	2.97	.....
iC_4	2.25	.07	7.87	2.18	13.74	20.91	.....	25.05	1.99
nC_4	7.05	.06	25.03	.....	50.86	76.78	1.16	1.98	95.87
iC_5	1.72	.....	6.14	.....	12.47	1.71	33.11	.....	2.14
nC_5	1.52	.....	5.44	.....	11.05	.....	32.23	.....	.....
C_6	1.09	.....	3.88	.....	7.89	.....	23.01	.....	.....
C_{7+}	.49	.....	1.77	.....	3.59	.....	10.49	.....	.....
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Flow:									
Mols./Hr.	5497.0	3959.0	1538.0	781.1	756.9	497.5	259.4	101.1	396.4
Lbs./Hr.	175835	92080	83755	34319	49436	28932	20504	5822	23110
GPM (Liquid)	.....	.....	299.3	135.8	163.5	100.0	63.5	20.75	79.25
MSCFD (Vap.)	50,000	36,011	.....	.....	.....	.....	.....	.....	.....

[1] Shown as total gas feed. Actually is approximately 27½ percent condensed at absorber feed condition.
[2] Absorbed constituents only shown. Raw gasoline to depropanizer is same.
[3] Debutanized gasoline only shown. May also produce 26-pound RVP gasoline.

from Tray 27 in the absorber and from the bottom section before the rich oil enters the reboiler. The lean oil to the column is flow controlled while bottom product specification is maintained by temperature controlling the reboiler. Residue gas from the column passes through the absorber residue scrubber which contains mist extractor elements to eliminate oil carry-over to the gas treating plant.

The rich oil from the absorber reboiler is flashed across a liquid level control valve into a rich oil flash tank operating at approximately 135 psig. Because of the extreme richness of the rich oil considerable vapor is flashed in this tank and thence passes directly to the fractionating section of the 120-inch i.d. by 20-tray still. The rich oil effluent from the flash tank then flows through a lean oil-rich oil exchanger after which it is heated in the still preheater to 400° F. and introduced into the still.

The still stripping steam passes through a conventional oil reclaimer and then to the still below the bottom stripping tray. A water dehydrator removes condensed stripping steam from the fractionation section of the still. The still overhead vapors flow to the air cooled fin-fan still reflux condenser. The still reflux pump returns approximately 160° F. reflux from the still reflux accumulator to the top of the still. Net production vapor and liquid leave the flooded reflux accumulator, pass through the still final condenser and to the depropanizer feed tank. As mentioned previously, because of the resultant deethanized rich oil from the absorber, total condensation is achieved at this point on the raw gasoline.

The still bottoms enter the heating oil pumps. The plant lean oil requirement is taken from the discharge of these pumps through the lean oil-rich oil exchanger, depropanizer preheater and lean oil cooler. The lean oil pumps receive the oil at this location and return it to the top of the absorber.

Because of the relative shortage of water in the West Texas area, the condensed stripping steam from the still, still reflux accumulator and depropanizer feed tank is not bled to the plant sewer system. The condensate is taken in a closed system to a skim tank located adjacent to the cooling tower. The skimmed water condensate is then dumped to the cooling tower basin as a portion of its make-up water requirements.

Approximately 300 gpm of raw gasoline is pumped to the depropanizer through a feed-gasoline exchanger and a preheater. The depropanizer feed pump is driven by a turbine utilizing a portion of the plant fuel requirements as the power source. Inasmuch as no reabsorption is required in the process, all plant fuel is derived from the absorber residue gas at 500 psig. It is only because the design raw gasoline rate of 300 gpm is so high compared with the lean oil rate that significant heat recovery can be made from the lean oil by utilizing it as the heat source for the depropanizer preheater.

The 84-inch (i.d.)-by-34-tray depropanizer produces a specification propane product overhead. The ethane content of this product is maintained

by the absorber bottom temperature control. The bottom product is depropanized sufficiently to allow subsequent production of specification isobutane. The propane product is taken from the discharge of the depropanizer reflux pump and cooled before passing to the propane caustic treater. Control on this column is conventional with the reflux controlled by the temperature a few trays from the top and flow control on the heat medium to the reboiler.

The depropanizer bottoms product is flashed to the feed tray of the 78-inch (i.d.)-by-32-tray debutanizer which operates at approximately 110 psig. This column and all its appurtenances are designed to produce a bottoms product ranging from a debutanized gasoline to a 26-pound RVP product. The overhead from this column is condensed with air cooling. The actual finned surface employed is arranged in the same fin-fan unit utilizing the same structure and common fans with the still reflux condenser.

The gasoline bottom product from the debutanizer reboiler is cooled by exchanging with the depropanizer feed and then cooling water before further processing. The debutanizer reflux is on flow control and reboiler heat medium on temperature control for normal operation of producing a certain vapor pressure gasoline. However, if it is desired to produce an essentially completely debutanized gasoline, it is only necessary to close and open a few small valves in the instrument air piping and change one thermocouple connection in an instrument case to reverse the functions of the above instruments.

The butane overhead product from the debutanizer reflux pump may either be cooled and passed to storage or introduced to the butane splitter. Actually, instrumentation is set up so that a portion may be directed each way if desired. The 84-inch (i.d.)-by-65-tray butane splitter operates at approximately 90 psig and is designed to produce a 95 percent isobutane overhead product and a 95 percent normal butane bottom product. Both overhead and bottoms products are cooled and sent directly to their respective storage tanks from this column. The reflux to the column is controlled by the column temperature a few trays from the top while the heating agent to the reboiler is flow controlled.

In addition to the above columns, the plant contains a 30-inch (i.d.)-by-20-tray rerun still. This column handles all accumulated slop oil from the high and low pressure gas gathering drip systems and the plant gas inlet scrubbers. In addition oil from the plant sewer and drain system is separated in a conventional API separator and sent to slop storage. The overhead from the rerun still, containing desirable recoverable products, is introduced into the plant process cycle for recovery, while the bottoms are sent to heavy slop storage for disposal. This column may be operated to produce the plant lean oil make-up requirements in the overhead product.

All heating for the section of the plant outlined above is accomplished with a heat medium system. The heating oil employed is identical with the plant lean oil which requires no duplication of storage facilities or process surge space. The process surge for both the heating oil system and the plant lean oil is contained in the bottom of the still.

As mentioned previously the still bottoms enter the heating oil pumps. The lean oil is taken from the discharge of these pumps. The heating oil stream is pumped to two direct-fired heaters operating in parallel which heat the oil to 500° F. The hot oil is then returned to the process area and passes through the following units in parallel: 1) Absorber reboiler; 2) Still preheater; 3) Oil reclaimer tube bundle; 4) Depropanizer reboiler; 5) Debutanizer reboiler; 6) Butane splitter reboiler and, 7) Rerun still preheater.

The oil from all of these services is returned to the bottom surge section in the still.

The fuel gas to each of the heaters is controlled by the oil temperature from the heaters. Safety shutdown equipment will automatically shut down the heaters in case of high stack temperatures, excessive oil flow or fuel gas pressure failure. These instruments are all contained on an outdoor panel located in the vicinity of the heaters.

Combination of the lean oil and heating oil system as described results in a very simple, easily operable and flexible system. Because of the small amount of equipment services employed maintenance is held to a minimum.

The residue gas from the absorber passes to the amine type gas treating plant. This unit is designed to remove 1.4 percent CO_2 and 5 grains of H_2S from approximately 36,000 Mscf per day of gas (the absorber residue resulting from 50,000 Mscf per day absorber feed) and produce a treated gas containing less than 0.25 grains of H_2S per 100 scf.

Approximately 80 gpm of a solution comprised of 25 percent monoethanolamine, 20 percent diethylene glycol and 55 percent water is circulated to the top of the 66-inch (i.d)-by-16-tray amine contactor. Rich solution from the contactor bottom is heated in an exchanger and introduced to the 36-inch (i.d.)-by-16-tray amine still. The regenerated hot lean solution from the reboiler passes back through the exchanger, is cooled and then pumped back to the contactor. Overhead vapor from this still passes to a condenser where the water vapor is condensed and then pumped from the following accumulator back to the still top as reflux while the remaining acid gas is sent out to a flare system.

The diethylene glycol is utilized in the solution for the purpose of reducing any solution foaming tendencies and to minimize corrosion in the reboiler. The amine reboiler is heated with steam rather than oil from the process heat medium system. This is because the use of the hot oil would give high skin temperatures on the reboiler tubes and result in a serious corrosion problem.

View of Compressor Piping Showing Headers and Laterals which Comprise a Portion of the Pulsation Dampening System.

Residue gas from the amine contactor passes to the sales gas distribution system.

The propane product from the depropanizer is treated with a two stage caustic wash employing duriron mixers, caustic circulating pumps and two 96-inch (i.d.)-by-40-foot caustic settlers. The effluent propane then enters some gravel filters for separation of any entrained caustic solution and then is dehydrated by means of a regenerative type florite unit.

The gasoline product from the debutanizer bottoms is treated for removal of mercaptans with Perco solid-type copper sweetening facilities.

The design plant production rate based on 50,000 Mscf per day feed gas is approximately 195,580 gallons per day of propane, 143,940 gallons per day of total butanes and 91,420 gallons per day of debutanized gasoline. Design 26-pound RVP gasoline production is 132,900 gallons per day with a corresponding decrease in total butanes. Isobutane production of approximately 29,880 gallons per day is design for the butane splitter in operation. Total design production of liquid products is 430,940 gallons per day.

Propane storage of approximately 12,000 barrels is realized by use of eight 126-inch (o.d.)-by-97-foot tanks. Total butane storage of 12,000 barrels is obtained in six 144-inch diameter tanks slightly over 91 feet long. Three of the six tanks are manifolded so they may be utilized for either isobutane or mixed butane storage. Gasoline storage comprises five 3000-barrel spheroids.

Other storage area facilities include three 1000-barrel LPG tanks, two 1000-barrel light slop tanks, one 500-barrel heavy slop tank, three 500-barrel lean oil tanks and rerun still bottoms storage.

A reciprocating utility pump located in the storage area may be used to rerun any off specification product material to the process area. This pump is also used to provide make-up lean oil to the plant.

One unusual feature of the Snyder plant is the underground storage provided for propane and butane. A salt structure underlies the entire area, and Sunray Oil Corporation, operator, drilled wells and circulated fresh water to dissolve salt to form underground cavities. The butane injection well reservoir has a capacity of approximately 1,800,000 gallons while underground storage capacity of propane, two injection wells, is approximately 2,800,000 gallons. These liquid products are removed by displacement by pumping salt water back into the reservoirs.

Vertical pumps are employed to ship plant production. There is one train-loading and one truck-loading pump for each product. The truck-loading rack consists of two double spots and gives a total of two outlets for isobutane loading and four each for propane, butane and gasoline. The train-loading rack, approximately 3½ miles from the plant site, consists of 24 double tank car loading spots. There are 48 loading spots for propane, butane and gasoline and eight outlets for isobutane.

Both truck and railroad loading facilities are maintained day and night. In the first six months of plant operation 6295 tank cars and 4869 tank trucks of liquid products were shipped.

Any vapor from product storage tankage and from the truck loading rack is returned to the compressor plant suction through a vapor return system. Vapor from the train loading rack is returned to the plant by tying into the low-pressure field gas gathering system.

The design use of process steam in the plant has been held to a minimum by utilizing the hot oil heat medium system for process heating. Other than a few small heating loads such as for regeneration vapor for the propane dehydrator, the only plant heating load is for the amine reboiler. The other principal use of steam in the plant is as the stripping agent for the lean oil still. The total plant load of 16,500 pounds per hour is generated at 250 psig in two package type 175-hp boilers. Actually each boiler is capable of developing full plant steam requirements.

A sizeable portion of the 250-psig steam is utilized in reciprocating pumps exhausting at 125 psig. Major users here are the compressor section interstage condensate pumps and the amine solution pumps. The amine reboiler and lean oil still derive their steam from the 125 psig system.

All make-up water and return condensate pass through a tray-type deaerating heater mounted on top of the boiler feedwater surge tank. Exhaust steam from the reciprocating boiler feedwater pumps supplies steam heat for the deaerator.

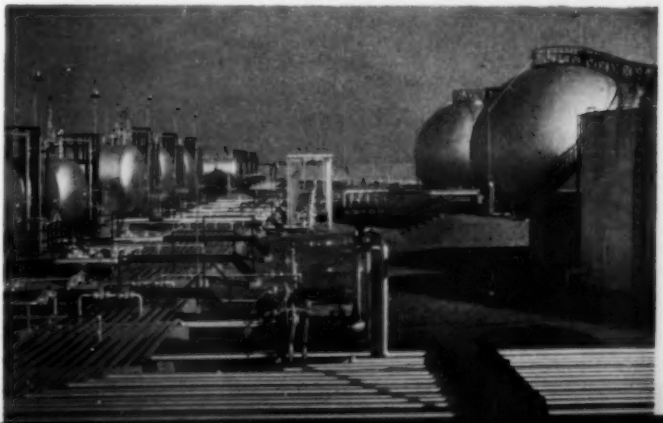
Water System

The plant make-up water requirements have been held as low as possible by means of minimum use of steam with attendant maximum use of hot oil for process heating and by maximum economical use of various air-cooled fin-fan cooling and condensing units. In addition, the condensed stripping steam from the still is recovered. All incoming plant make-up is treated in a conventional cold lime type water treating plant. Effluent from this treater to the cooling tower is treated further with acid. The boiler feedwater make-up passes through a sodium zeolite unit after leaving the cold lime section with supplemental treatment consisting of sulphite and phosphate at the boiler feed point.

All water cooled heat exchange equipment in the plant consists of shell and tube units. Vertical type pumps in a sump adjacent to the cooling tower basin circulate the plant cooling water requirements through all the coolers and condensers and return to the top of a three cell induced draft cooling tower. The cooling tower is designed for a five degree approach to a 72° F. wet bulb. The coldest economical water temperature is important for absorber operation.

The plant water is stored in a 10,000-barrel tank located on the high point of the plant site. A gas-gasoline

Spheroids, right, for Natural Gasoline and Horizontal Tanks, left, for LPG, Iso-Butane, n-Butane and Propane. Center, Vertical Loading Pumps. Note overhead structure for maintenance.



engine driven fire pump is located adjacent to this tank.

Plant power requirements were held as low as feasible by use of available energy from steam and plant fuel gas. All pumps with the exception of a few previously mentioned are motor driven, as are all fans on air cooled units and the cooling tower. Four 500-kw, 480-volt, 450-rpm, gas engine-driven generators supply the plant power requirements. One of these units serves as a spare with three operating to handle the required plant load.

Switchgear and feeder panels in one continuous line are located in the auxiliary building opposite the generators. Feeder breakers are provided to protect separate feeders to the process area, compressor area, cooling tower, product loading area, and the auxiliary area consisting of generators, boilers, and heaters. Motor starters for the auxiliary area are located in the auxiliary building while those for the other areas mentioned above are explosion proof starters located as close as practicable to the units they serve.

Instrumentation

The central control house is located in the center of the process area to house all controls and major instruments for this portion of the plant. Bellows-type pneumatic transmitters have been used for all flow recorders and controls, while all temperature instruments are electronic. All pressure instruments are sealed so that no hydrocarbons enter the control house.

A panel located inside the compressor building serves requirements in that area while the same is true in the auxiliary building. The fired heaters are controlled by an outside panel located in the vicinity of the heaters.

The physical arrangement of all mechanical equipment and piping in the plant permits ease of repairs and maintenance and yet is as compact as operating flexibility and safety practices will allow.

Table 1

Absorption Plant Data	Design	Test
Composite Inlet Gas Stream, MMscfd	50.0	50.7
Temperature, °F.	82	82.4
GPM. Propane and Heavier	10.10	9.66
Composition, Mol Percent:		
Methane and Lighter	47.84	50.50
Ethane	18.64	17.65
Propane	19.40	18.32
Isobutane	2.25	2.17
Normal Butane	7.05	5.91
Isopentane	1.72	1.08
Normal Pentane	1.52	2.16
Hexanes and Heavier	1.58	2.21
	100.00	100.00
Residue Gas Stream, MMscfd	**36.0**	**37.1**
Composition, Mol. Percent:		
Methane and Lighter	66.37	69.19
Ethane	25.35	23.35
Propane	8.08	7.34
Isobutane	0.07	0.03
Normal Butane	0.06	0.03
Isopentanes and Heavier	0.07	0.06
	100.00	100.00
Absorber Pressure, psig.	500	490
Product Recoveries, Percent:		
Propane	70.0	70.8
Isobutane	98.0	99.0
Normal Butane		99.6
Pentanes and Heavier	99.0	99.2
Product Purity, Percent Liquid Vol.		
Propane	95.0	93.8
Isobutane	95.0	97.3
Butane	95.0	94.0

All coolers and condensers are located at ground level so that tubes may be readily cleaned. An elevated accumulator structure in the middle of the process area between the still and the depropanizer holds the still reflux accumulator, depropanizer feed tank, and depropanizer and debutanizer reflux accumulators.

All pumps and drivers are located outside near their suction source. Beneath the accumulator structure mentioned above is a solid concrete slab on which the heating oil, still reflux, depropanizer feed and depropanizer and debutanizer reflux pumps are located. Although no pump house is included in the plant the above open structure partially serves this purpose.

The liquid product treating and caustic storage and mixing facilities are all grouped as a unit. The same is true of the amine gas treating unit.

Actual operation of the plant and controlled tests have shown the plant as a whole to perform entirely satisfactory. The test results of the de-ethanizing absorber in particular have been extremely gratifying.

Table 1 gives some of the comparative design and actual performance test data for the absorber. The test was of 12-hour duration and all variables, including cooling water temperatures, were set as close to design conditions as possible. The design figures shown are based on no absorber intercooling while the actual test results include the absorber intercooler in operation. The actual test composite feed gas to the absorber was somewhat leaner than design feed gas, and the molal lean oil flow was somewhat lower for the test than for design. The propane product purity was slightly less than 95 percent as it was desired to produce propane with a slightly higher vapor pressure. However, test operating results check very closely those predicted by the methods and procedures used in the process design of the absorber.

During the colder winter months with correspondingly colder cooling water temperatures, actual production rates have exceeded design rates considerably. Sunray has reported that during a six-day period in January the plant produced at an average daily rate of 220,290 gallons of propane, 40,230 gallons of isobutane, 93,680 gallons of normal butane and 160,230 gallons of 18-pound RVP natural gasoline for a total daily average production of 514,430 gallons. The plant processed an average of 57,710 Mscf per day of gas for this particular period. The corresponding plant design figures, based on summer operation are 50,000 Mscf of gas with a total liquid production of 430,940 gallons.

The Snyder plant was completed and put into operation ten months and 20 days after a letter of intent was issued to the engineering contractor. Considering that this was all accomplished after the outbreak of hostilities in Korea it is believed to be almost record time and was only possible because of complete cooperation of all parties involved.

General View of Process Area. Gas Treating Facilities at left, Product Fractionators in center, and Deethanizing Absorber on right.

ACKNOWLEDGMENT

The writer wishes to thank Sunray Oil Corporation, operator of the Snyder gasoline plant for permission to publish this article and information contained herein.

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West Texas Natural Gasolines—Their Compositions and Properties

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A KNOWLEDGE of the composition of natural gasolines is essential for the evaluation of these stocks as sources of premium quality hydrocarbons. Here is presented the results of a precise determination of the composition and properties of two West Texas natural gasolines. These gasolines were carefully fractionated into 0.1 volume percent or smaller fractions which were analyzed to determine the compositions. About 95 percent of the debutanized gasolines were quantitatively identified as individual hydrocarbons; the unidentified components were in the eight-carbon and heavier fractions. The distribution of sulfur in these gasolines was also determined as were the antiknock and other physical properties of fractions simulating products that are or could be manufactured commercially.

NATURAL gasoline is a mixture of paraffins, naphthenes, aromatics and organic sulfur compounds. Considered as a propane and heavier product, roughly three-fourths of the gasoline is accounted for by propane, isobutane, normal butane, isopentane and normal pentane. The characteristics of these hydrocarbons and their concentrations in natural gasolines from various sources have been fairly well established. Also, the characteristics of the various hexanes, many of the heptanes, and a few of the octanes are well known. However, very little information is available on the identity and concentration of the minor components.

Recognizing the present trends in spark-ignition engine design and the accompanying trends in fuel quality, it is apparent that the premium value of high antiknock quality hydrocarbons will continue to increase. Further, the value of high purity hydrocarbons is being increased by the demands of the rapidly expanding petrochemical industry. Before the technical and economic aspects of the recovery of these premium value hydrocarbons from natural gasolines can be fully evaluated, the composition of these natural gasolines must be known. The results of a detailed study of the composition of two West Texas natural gasolines, recently completed in Phillips Petroleum Company's Philtex Experiment Station facilities, are presented herewith.

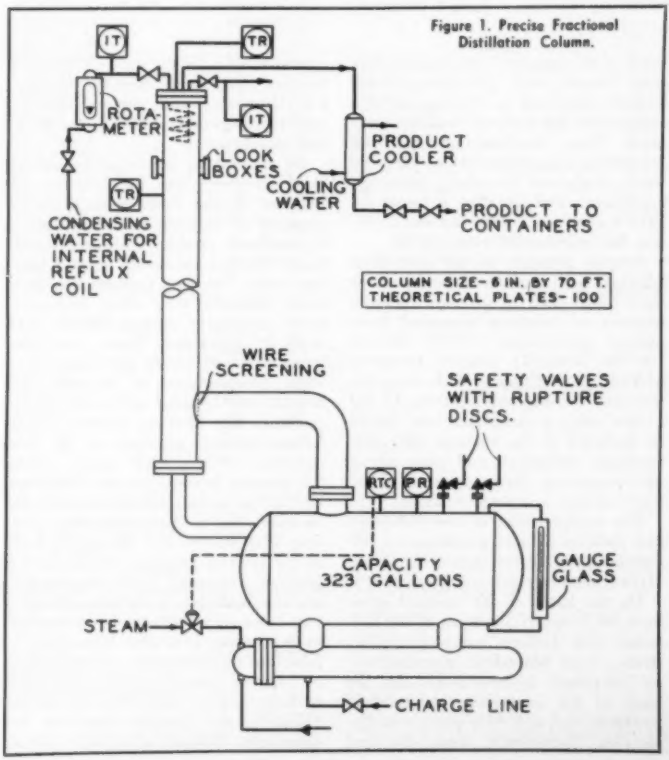

Figure 1. Precise Fractional Distillation Column.

Samples of approximately 1000 gallons each of the deethanized natural gasolines were obtained from the Phillips Fullerton and Judkins natural gasoline plants for evaluation. The samples were desulfurized, and the gasolines then debutanized in a 10-inch batch distillation column packed with ½-inch ceramic Berl saddles. This column is estimated to be equivalent to 40 theoretical plates at total reflux. An apparent reflux to overhead product ratio of 100 to 1 was maintained during the fractionations. The debutanizations were stopped before neopentane appeared in the overhead products.

About 250 gallons of each of the debutanized gasolines was subjected to a precise distillation in a 6-inch by 70-foot batch distillation column. This column, a simplified sketch of which is shown in Figure 1, was packed with ⅜-inch ceramic Raschig rings and was estimated to be equivalent to 100 theoretical plates at total reflux. An

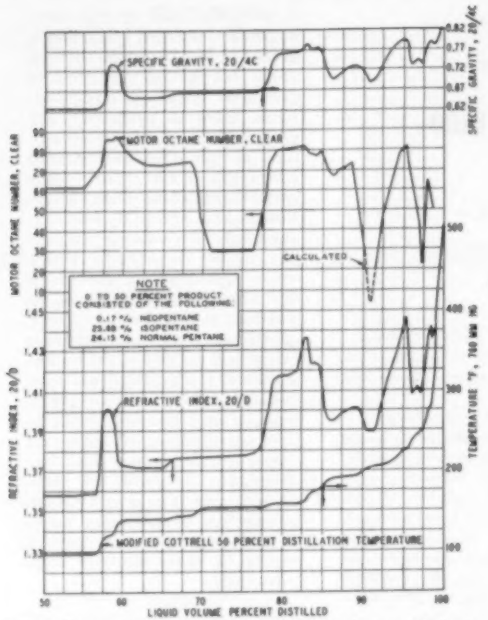

Figure 2. Characteristics of Individual Fractions of Debutanized Fullerton Gasoline.

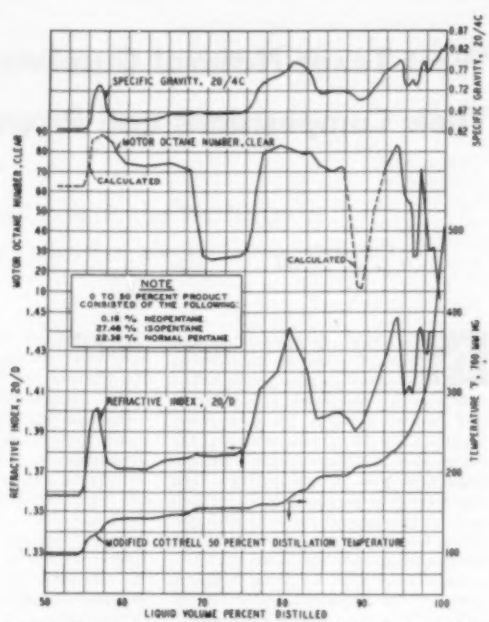

Figure 3. Characteristics of Individual Fractions of Debutanized Judkins Gasoline.

apparent reflux to overhead product ratio of 100 to 1 was maintained throughout the distillation. The entire still charge was taken overhead and collected in individual fractions of approximately one-half gallon in volume. In order to take the last ten gallons of material overhead it was necessary to introduce steam into the kettle and to continue the fractionation by steam distillation. The exact amount of each overhead cut was determined by weighing.

Modified Cottrell distillations and API gravity determinations were run on all fractions boiling in the isopentane and heavier range. Specific gravities and refractive indices were determined on most of the cuts heavier than normal butane. Quantitative infrared analyses were performed on all cuts, except those containing major concentrations of hydrocarbons boiling above methylcyclohexane and a number of cuts from the butane and pentane plateaus. Most of the butane and pentane fractions were of such high purity that it was not necessary to analyze every fraction.

The aromatic content of the samples, including those containing ethylbenzene and xylenes, was determined on an ultraviolet spectrophotometer. In order to obtain more reliable results for the naphthenes and paraffins, some of the samples high in aromatics were treated with phosphoric anhydride dissolved in fuming sulfuric acid before the infrared analyses were made. Those fractions that could not be analyzed quantitatively by infrared were analyzed for their aromatic, naphthene, and paraffin contents by PONA analyses; these fractions represent the unidentified components.

Aliquot portions of the individual fractions boiling above normal pentane were composited to simulate common commercial fractions separated from natural gasolines. ASTM Motor (ASTM D357-47) octane numbers, without the addition of TEL, were determined on selected fractions to aid in determining which fractions should be included in the various composite fractions. Antiknock and other physical properties were determined on these various composite fractions.

The compositions of the Fullerton and Judkins natural gasolines, as calculated from the fractionation and analytical data, are presented in Table 1.

On the basis of the original gasolines, 98.1 and 97.5 percent of the Fullerton and Judkins samples, respectively, were identified quantitatively as individual hydrocarbons; on the basis of the completely debutanized products 95.6 and 94.6 percent of the samples, respectively, were identified quantitatively. Of the eight-carbon and heavier components only the xylenes, ethylbenzene and part of the trimethylcyclopentanes could be identified quantitatively.

Of interest in the separation of these gasolines was the behavior of benzene in the fractionation. Small amounts of benzene began appearing in overhead product boiling as much as 40 degrees below its normal boiling point. The data indicate that benzene codistills with other hydrocarbons, especially normal hexane and methylcyclopentane. There were plateaus observed which had fairly constant compositions of benzene and hexane, and benzene and methylcyclopentane. The benzene content of the hexane-benzene plateaus of the two gasolines were not the same; 2.4 to 2.5 percent benzene for the Fullerton and 3.0 to 3.1 percent benzene for the Judkins. The methylcyclopentane-benzene plateau was not sharply defined in the Judkins gasoline; the Fullerton gasoline, however, had considerable plateau material containing 9.6 percent benzene and 90.4 percent methylcyclopentane. It is also interesting to note that the maximum concentrations of benzene were reached in fractions boiling at 165.2 and 168.7 F. in the Fullerton and Judkins gasolines, respectively, instead of at its normal

boiling point of 176.2 F. The benzene content of cuts boiling at 176 F. contained approximately one percent benzene compared to the 27.1 and 35.0 percent at the maximum concentrations 11 to 8 degrees lower.

Other items of special interest are the identification of 0.16 to 0.17 percent neopentane in the debutanized gasolines and the presence of ethylcyclopentane and trimethyl cyclopentanes. No cyclopropane or cyclobutane, and none of the highly branched paraffins such as triptane and 2,2,4-trimethylpentane were found.

The compositions of the two debutanized gasolines by hydrocarbon types are summarized in Table 2.

In order to determine the sulfur distribution in the original undesulfurized natural gasolines, samples of these products were precisely fractionated in a laboratory column into cuts simulating those products commercially separated from the gasolines. The sulfur contents of these various cuts as well as those of the original undesulfurized natural gasolines

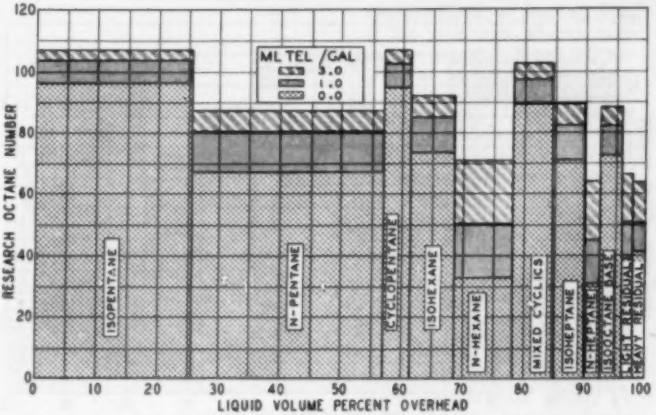

Figure 4. Research Octane Numbers for Composite Fractions of Debutanized Fullerton Natural Gasoline.

TABLE 1
Composition of Debutanized West Texas Natural Gasolines

Component	Debutanized Gasoline Liquid Volume Percent: Fullerton	Judkins
Neopentane	0.17	0.16
Isopentane	25.68	27.46
Normal Pentane	31.12	27.36
Cyclopentane	1.59	1.57
Neohexane	0.21	0.20
Diisopropyl	0.96	0.94
2-Methylpentane	6.34	6.13
3-Methylpentane	3.43	4.32
Normal Hexane	8.39	7.48
Methylcyclopentane	4.20	3.60
2,3-Dimethylpentane	0.08	0.09
Benzene	0.87	1.12
2,4-Dimethylpentane	0.18	0.27
Cyclohexane	1.82	2.34
3,3-Dimethylpentane	0.07	0.10
1,1-Dimethylcyclopentane	0.29	0.21
2,3-Dimethylpentane	0.18	0.45
2-Methylhexane	1.05	0.95
trans 1,3-Dimethylcyclopentane	0.78	0.99
trans 1,2-Dimethylcyclopentane	0.80	0.90
cis 1,3-Dimethylcyclopentane	0.61	0.45
3-Methylhexane	1.41	1.35
3-Ethylpentane	0.04	0.05
Normal Heptane	2.37	2.30
cis 1,2-Dimethylcyclopentane	0.11	0.03
Methylcyclohexane	1.62	1.88
Ethylcyclopentane	0.14	0.11
1,1,2-Trimethylcyclopentane	[a]	0.15
2,2-Dimethylhexane	[b]	0.09
2,5-Dimethylhexane	[b]	0.18
1, trans 2, cis 4-Trimethylcyclopentane	(0.63)[a]	0.17
2,4-Dimethylhexane	[b]	0.07
1, trans 2, cis 3-Trimethylcyclopentane	[a]	0.21
Toluene	0.56	0.74
3-Methylheptane	[b]	0.04[c]
4-Methylheptane	[b]	0.02[c]
Ethylbenzene	0.09	0.13
para-Xylene	0.02	0.02
meta-Xylene	0.06	0.07
ortho-Xylene	0.02	0.03
Unidentified	4.39	5.42
	100.00	100.00

[a] Values for Trimethylcyclopentanes are lumped-total estimated from PONA analyses and physical properties.

[b] These compounds were not analyzed for in this gasoline; they are included with the unidentified components.

[c] Not complete.

TABLE 2
Distribution of Hydrocarbons by Type in Debutanized West Texas Natural Gasolines

Hydrocarbon Type	Fullerton Gasoline	Judkins Gasoline
Paraffins, liquid volume percent	83.6	82.5
Naphthenes, liquid volume percent	14.5	15.1
Aromatics, liquid volume percent	1.9	2.4
	100.0	100.0

TABLE 3
Distribution of Sulfur in West Texas Natural Gasolines

	Boiling Range, °F. at 760 mm Hg.	Liquid Volume Percent of Desthanized Gasoline: Fullerton	Judkins	Sulfur Weight Percent: Fullerton	Judkins
Propane	— 50 to — 27	22.1	15.0	.....	.....
Isobutane	— 27 to 21	6.4	10.9	0.0044	0.0186
Normal Butane	21 to 42	28.7	31.8	0.0096	0.0085
Isopentane	42 to 90	11.6	11.5	0.0532	0.0559
Normal Pentane	90 to 105	13.3	11.9	0.0602	0.0858
Cyclopentane	105 to 138	1.1	2.2	0.2163	0.3519
Isohexanes	138 to 150	4.1	4.0	0.0299	0.0296
Normal Hexane	150 to 156	4.4	4.1	0.0026	0.0057
Mixed Cyclics	158 to 180	1.6	1.7	0.2244	0.2293
Isoheptane	180 to 197	1.6	1.6	0.0819	0.2356
Normal Heptane	197 to 209	1.4	0.9	0.0227	0.0633
Isooctane Basestock	209 to 220	1.3	1.5	0.0310	0.0158
Light Residual	220 to 267	1.4	1.9	0.3268	0.3164
Heavy Residual	267 to E.P.	1.0	1.0	1.64	0.903
Total Debutanized Gasoline		43.8	43.3	0.1133	0.1255

TABLE 4
Typical Composition of Composite Fractions

Components	FRACTIONS: Isopentane	Normal Pentane	Cyclopentane	Isohexanes	Normal Hexane	Mixed Cyclics	Isoheptanes	Normal Heptane	*Isooctane Basestock	†Light Residual
Neopentane	0.7	.....	.....	.....	.....	.....	.....	.....	.....	.....
Isopentane	99.0	0.9	.....	.....	.....	.....	.....	.....	.....	.....
Normal Pentane	0.3	99.0	1.2	.....	.....	.....	.....	.....	.....	.....
Cyclopentane	.....	0.1	34.7	.....	.....	.....	.....	.....	.....	.....
Neohexane	.....	.....	4.8	.....	.....	.....	.....	.....	.....	.....
Diisopropyl	.....	.....	13.9	0.8	.....	.....	.....	.....	.....	.....
2-Methylpentane	.....	.....	45.4	59.2	.....	.....	.....	.....	.....	.....
3-Methylpentane	.....	.....	.....	39.8	5.1	.....	.....	.....	.....	.....
Normal Hexane	.....	.....	.....	0.2	87.4	1.3	.....	.....	.....	.....
Methylcyclopentane	.....	.....	.....	.....	4.7	61.2	.....	.....	.....	.....
Benzene	.....	.....	.....	.....	2.8	8.7	.....	.....	.....	.....
2,3-Dimethylpentane	.....	.....	.....	.....	.....	1.4	.....	.....	.....	.....
2,4-Dimethylpentane	.....	.....	.....	.....	.....	2.7	.....	.....	.....	.....
Cyclohexane	.....	.....	.....	.....	.....	24.1	4.7	.....	.....	.....
3,3-Dimethylpentane	.....	.....	.....	.....	.....	0.2	3.1	.....	.....	.....
1,1-Dimethylcyclopentane	.....	.....	.....	.....	.....	0.4	3.7	.....	.....	.....
2,3-Dimethylpentane	.....	.....	.....	.....	.....	.....	4.8	.....	.....	.....
2-Methylhexane	.....	.....	.....	.....	.....	.....	18.7	.....	.....	.....
Dimethylcyclopentanes	.....	.....	.....	.....	.....	.....	39.3	6.3	.....	.....
3-Methylhexane	.....	.....	.....	.....	.....	.....	24.1	2.3	.....	.....
3-Ethylpentane	.....	.....	.....	.....	.....	.....	0.3	1.0	.....	.....
Normal Heptane	.....	.....	.....	.....	.....	.....	1.3	69.5	.....	.....
Methylcyclohexane	.....	.....	.....	.....	.....	.....	.....	16.6	.....	.....
Ethylcyclopentane	.....	.....	.....	.....	.....	.....	.....	3.2	.....	.....
Toluene	.....	.....	.....	.....	.....	.....	.....	0.1	.....	.....

* Contains about 13 percent toluene plus methylcyclohexane, trimethylcyclopentanes, dimethylhexanes and methylheptanes.

† Contains about 12 percent C8 aromatics, plus normal octane and intermediate boiling compounds.

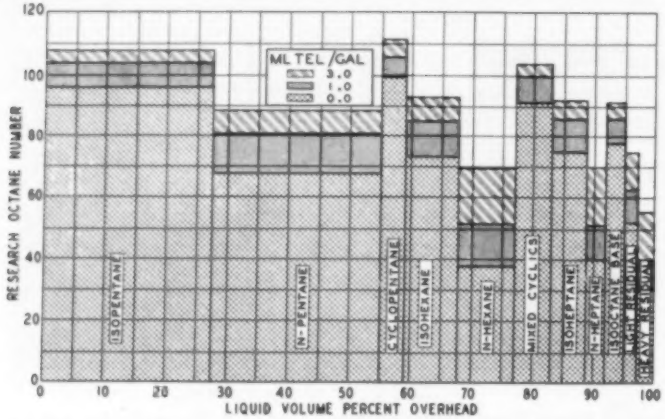

Figure 5. Research Octane Numbers for Composite Fractions of Debutanized Judkins Natural Gasoline.

were determined using lamp and quartz tube methods. These data are reported in Table 3. The cyclopentane, mixed cyclics and isoheptane fractions were found to have the highest sulfur concentrations with the exception of the light and heavy residuals.

The ASTM Motor octane numbers, specific gravities, refractive indices, and modified Cottrell 50 percent distillation temperatures of the individual fractions of the two debutanized gasolines are plotted in Figures 2 and 3. The volume percentages shown in these figures are based on the butane-free charge to the fractionation.

The approximate composition of the composite fractions, representing products normally separated from natural gasolines are shown in Table 4. Antiknock and inspection data determined on these composite fractions are presented in Table 5. The Reid vapor pressures, ASTM distillations, API gravities and Motor (ASTM D357-47) and Research (ASTM D908-47T) TEL curves with 0.0, 1.0 and 3.0 ml TEL were determined for each composite fraction. Aviation Octane Numbers (ASTM D 614-47T) and supercharge rich ratings (ASTM D 909-47T) with 3.0 and 4.0 ml TEL were determined on those composite fractions which were of aviation base stock quality. Figures 4 and 5 present graphically the ASTM Research octane numbers of the various composite fractions making up the debutanized gasolines. In this article all octane numbers above 100 are expressed in accordance with a slight modification of the octane number extension scale proposed by Trimble and Richardson.[1]

It is evident from Table 5 and Figures 4 and 5 that several base stocks of dissimilar quality can be separated from natural gasolines by distillation. These base stocks may be selectively blended with other base stocks or blending agents to produce aviation gasolines, motor fuels, jet fuels or solvents. The high supercharge rich ratings of the cyclopentane and mixed cyclics fractions justify their separation for use in selective blending of premium aviation gasolines.

ACKNOWLEDGMENT

The authors thank Phillips Petroleum Company for permission to publish this paper, and acknowledge the assistance of H. C. Walters, M. E. Flinn and C. A. Ray in the evaluation of the gasolines and in the preparation of this paper.

REFERENCE

[1] H. M. Trimble and J. O. Richardson, Oil and Gas Journal 35 (34), 40 (1937).

TABLE 5

Inspection and Antiknock Data for Composite Fractions of West Texas Natural Gasolines

	Liquid Volume Percent of Debutanized Gasoline	API Gravity	Reid Vapor Pressure	ASTM Distillation F[a]		Motor Octane Number ml TEL/Gal.			Research Octane Number ml TEL/Gal.			Aviation Lean Octane Number ml TEL/Gal.		Supercharge Rich Rating[b] ml TEL/Gal.	
				IBP	DP	0.0	1.0	3.0	0.0	1.0	3.0	3.0	4.0	3.0	4.0
DEBUTANIZED FULLERTON GASOLINE															
Isopentane[c]	25.850	95.1	20.0	80	86	....	....	107.6[d]	95.7[d]	103.4[d]	106.7[d]	....	....	....	....
Normal Pentane[c]	31.171	92.7	15.7	92	100	....	....	86.7	67.4	80.1	87.2	....	....	....	....
Cyclopentane	4.330	73.1	8.45	125	136	86.9	95.0	101.4	94.4	102.1	107.0	97.0	99.2	190.7[e]	203.5[e]
Isohexane	7.396	82.1	6.40	140	143	74.0	86.9	93.2	73.8	84.9	91.7	93.3	95.8	92.7	95.0
Normal Hexane	9.494	78.8	4.90	152	155	40.7	54.9	69.4	35.3	50.6	71.1	66.0	68.9	....	76.4[f]
Mixed Cyclics	6.382	82.9	3.95	162	169	79.6	87.5	90.5	80.3	87.2	102.3	85.4	87.3	193.1[g]	197.4[f]
Isoheptane	5.261	64.9	2.15	188	194	69.9	81.3	88.9	71.2	82.7	89.2	85.6	88.5	93.6	96.4
Normal Heptane	2.630	69.7	1.75	204	208	35.6	50.3	64.6	31.0	45.3	64.1	....	65.6	....	....
Isooctane Base	3.525	53.0	1.35	212	229	70.5	79.7	85.9	73.0	82.2	88.6	82.8	85.0	96.0	97.6
Light Residual	1.645	59.1	0.65	245	256	37.7	53.8	67.1	38.9	51.0	66.7	....	....	....	....
Heavy Residual	2.326	44.6	0.15	284	523[h]	34.2	50.0	60.7	41.3	51.0[e]	64.0	....	....	....	....
DEBUTANIZED JUDKINS GASOLINE															
Isopentane[c]	27.640	95.1	20.0	80	86	....	....	107.6[d]	95.7[d]	103.4[d]	106.7[d]	....	....	....	....
Normal Pentane[c]	27.758	92.7	15.7	92	100	....	....	86.7	67.4	80.1	87.2	....	....	....	....
Cyclopentane	3.765	71.0	7.00	122	134	87.8	97.4	102.0	98.4	105.4	110.7	102.0	104.2	210.1[e]	221.5[e]
Isohexane	8.766	82.4	6.60	140	142	73.4	87.5	93.3	72.9	84.3	92.0	92.9	97.1	92.5	95.0
Normal Hexane	9.099	77.5	5.05	152	155	36.6	58.9	71.7	37.6	51.9	69.1	68.7	71.7	....	....
Mixed Cyclics	6.023	82.3	4.15	161	173	80.7	87.4	91.0	90.4	97.8	103.0	88.0	90.2	188.8[f]	191.9[f]
Isoheptane	5.680	63.8	2.50	189	194	74.0	85.6	90.9	74.8	85.5	91.3	89.3	91.5	96.5	99.2
Normal Heptane[c]	3.042	64.3	1.70	205	209	....	....	65.7	39.9	51.1	69.6	....	....	....	....
Isooctane Base	3.212	51.9	1.35	214	233	73.2	....	87.9	77.4	85.9	90.6[e]	87.8	89.3	97.7	100.6
Light Residual	2.178	55.2	0.65	246	266	49.2	63.1	73.1	51.8	62.3	74.2	....	....	....	....
Heavy Residual	2.837	44.6	0.05	296	502[h]	35.8	....	50.6	29.1	40.5[e]	55.7	....	....	....	....

[a] Evaporated temperatures corrected to 760 mm Hg.
[b] Octane number.
[c] Average quality data.
[d] Blending octane number; 40 percent of sample blended with 60 percent of a paraffin-naphthene base having an unleaded Research octane number of 72.3.
[e] Blending index number; 30 percent of sample blended with 70 percent of base rating 97.2 and 99.7 octane number with 3.0 and 4.0 ml TEL/gal., respectively.
[f] Blending index number; 40 percent of sample blended with 60 percent of base used in (e).
[g] Estimated.
[h] End point.

NOTE: Octane numbers above 100 are assigned in accordance with a slight modification of the octane number extension scale proposed by Trimble and Richardson.[1]

Correlating Heat Quanities of Lower Hydrocarbons, Other Gases

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THE METHOD of plotting data of the properties of one substance against those of another so successfully used in correlating, interpolating, and extrapolating data of many physical and chemical properties[9] has been applied also to entropies and enthalpies of pure and mixed lower hydrocarbons and other gases. Straight lines result when the entropies of pure or mixed hydrocarbons are plotted vertically on a standard sheet of graph paper against the entropies, always at the same temperature, taken horizontally of a similar, known material. This is done simply by calibrating the horizontal axis with temperatures corresponding to the entropies of the standard material and plotting directly on the temperature ordinates so erected. Entropies at different pressure are found to give parallel isobars. For a homologous series of gases at the same pressure, entropies above the same temperature are readily plotted from a minimum of data as a sheaf of lines through the origin.

By a similar plot at constant pressure, enthalpies of lower hydrocarbons and other gases may also readily be correlated against those of a reference substance. A linear plot of enthalpies against a derived and non-uniform temperature scale results again; and a single line represents all pressures.

These correlations of entropy and enthalpy have been tested for gaseous paraffins, olefins, diolefins, and alkylcyclic compounds as well as for diatomic gases. The deviations of the correlations from experimental values are less than one percent.

THE empirical correlation of Scheibel and Jenny[11] gives entropy and enthalpy data for some hydrocarbons; and some other charts for a few substances are in handbooks; but ready, simple, accurate and general correlations for gases (by which is included vapors) over wide ranges are not available.

It was desired to attempt for these heat quantities the general methods which have been used for correlating many other properties of gases and liquids[7, 8, 9] which depend on plotting values in relation to those of a reference substance.

A correlation resulted for entropies and enthalpies of lower hydrocarbons and other gases which is based on the construction of a chart containing only straight lines, capable of accurately representing these thermodynamic properties, over a wide range, from a minimum of data. Practical, rapid construction of these plots can be made for any gaseous material to predict and use these heat quantities so useful in many engineering calculations at conditions for which experimental data are not immediately available. The correlation also allows ready comparison and evaluation of experimental data.

Construction of Entropy Plots

At constant pressure a plot on standard graph paper of the entropy of one gas against the entropy of a related gas taken at the same temperature was found to give a straight line through the origin. Hence, if the temperature—entropy relation is known for one gas, the entropy of a homologous gas is needed only at one temperature in order to establish the complete relation. (Entropies are always taken above the same datum temperature). Alternately, since the line passes

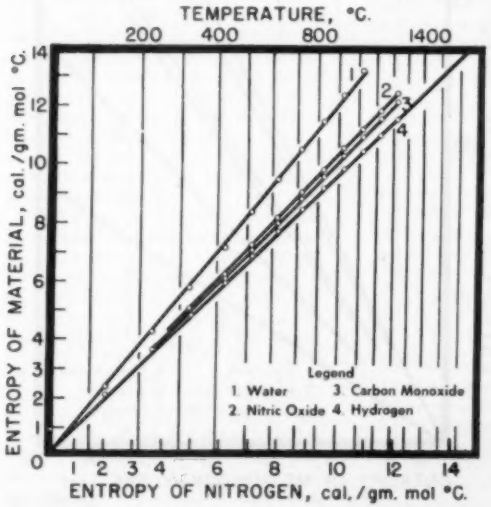


Figure 1. Entropy above 25° C. of Inorganic Gases.

through the origin, there is necessary only the value of its slope, which has been found to be equal to the ratio of the isobaric specific heats of the gases.

In the accompanying plots, Figures 1 through 5 inclusive, the data of Rossini[11] for different families of gases at atmospheric pressure have been thus examined; and each family gives a sheaf of straight lines, converging at the origin. Thus the correlation has been confirmed for steam, diatomic gases, olefinic and diolefinic gases, acetylenes, and cyclic hydrocarbon gases.

In Figure 1 entropy values of steam, nitric oxide, carbon monoxide, and hydrogen are plotted, as follows:

1) On the uniform X axis of a standard sheet of graph paper, the values of entropy of nitrogen are indicated; then the corresponding values of temperatures from standard data[11] are calibrated on the same axis.
2) Ordinates are erected at these values of temperature.
3) On these temperature ordinates entropy values of several gases (steam, nitrous oxide, carbon monoxide, and hydrogen) are plotted against the uniform scale for entropy along the vertical axis.
4) Lines, connecting these points, are

Figure 2. Entropy above 25° C. of Paraffin Hydrocarbon Gases.

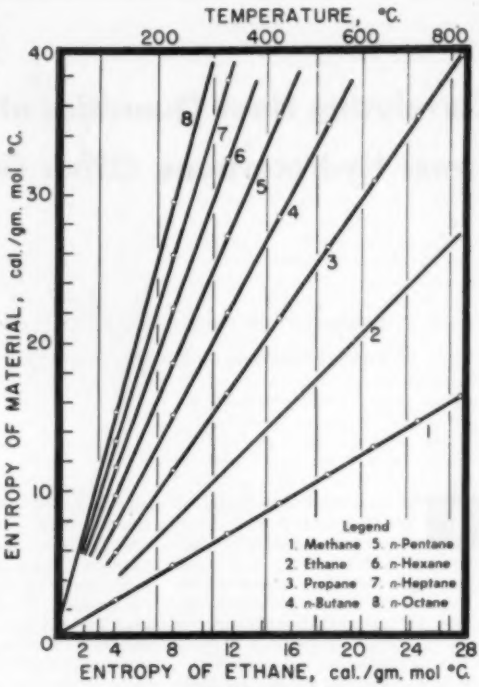
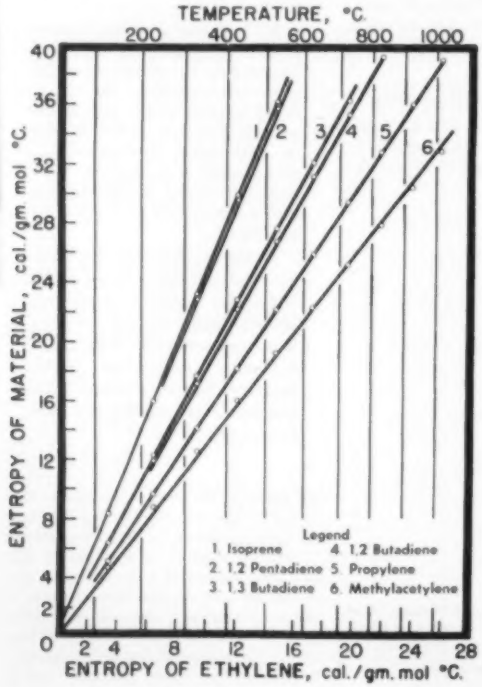
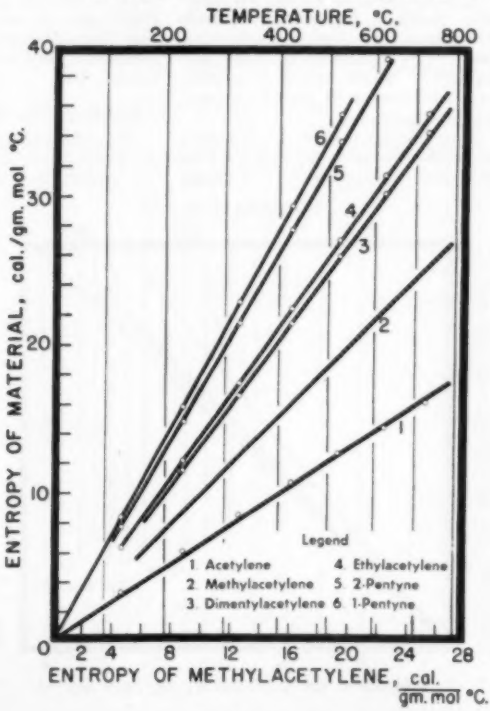


Figure 3 (left, below). Entropy above 25° C. of Straight Chain Unsaturated Hydrocarbon Gases.

Figure 4 (right, below). Entropy above 25° C. of Acetylene Vapors.





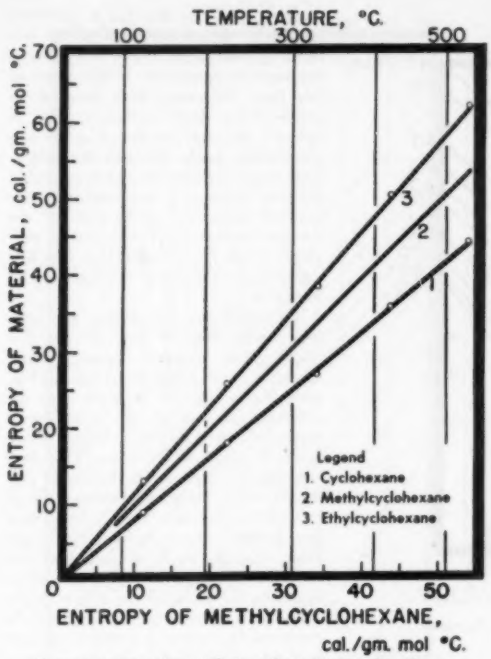


Figure 5. Entropy above 25° C. of Cyclic Hydrocarbon Vapors.

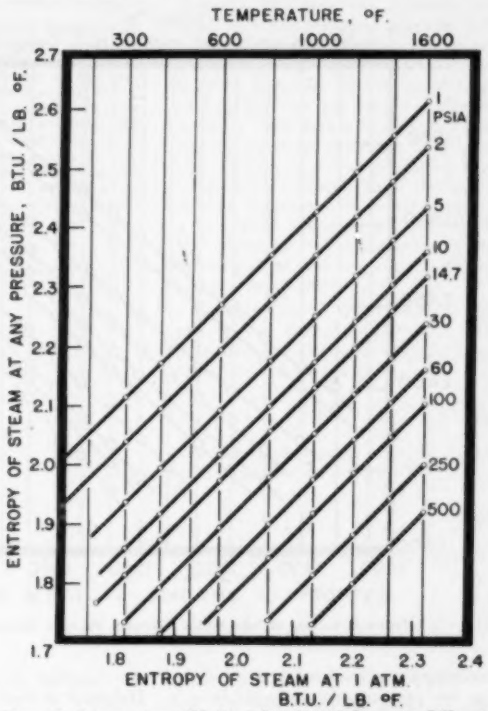


Figure 6. Entropy above 32° F. of Superheated Steam at Different Pressures.

drawn. Each is straight and passes through the origin.

In Figure 3 the entropies of diolefins and of acetylenes are plotted similarly against the temperature scale derived from the temperature—entropy data of ethylene, used as the reference gas. Straight lines through the origin result again. The line for methylacetylene deviates slightly, possibly not more than the error in the original experimental data. It is desirable to choose a reference gas from the same homologous series if data are available; a reference gas from a closely related hydrocarbon series may be used, however, with a slightly lesser degree of accuracy.

In Figures 2, 4, and 5 reference gases from the same homologous series have been used; and excellent agreement is exhibited by the correlations of saturated, straight chain hydrocarbons in Figure 2, as well as by the acetylenes in Figure 4. The slopes of the lines are the ratio of the isobaric specific heats of the gas and the reference gas. This ratio is seen to be constant, since the lines are straight; and their slopes do not change. Thus, it follows that the entropy reference plot may be employed advantageously in the prediction of complete data from meager or scattered data. If either one point (entropy at one temperature) or the slope (specific heat ratio at any temperature) is known, the entire entropy line may be drawn immediately.

The fact that a single point of entropy determines the entire line is of even more practical value when working with a gas mixture. The single point may be determined readily from a gas analysis by summing the entropies of the component parts, since experimental measurements of heat quantities would not usually be available. Alternately a single specific heat value would enable the determination of the slope. For an industrial gas mixture of constant composition as is often met in natural gas work, this single line suffices. If the composition of the process gas changes from time to time, a sheaf of lines through the origin may be used, readily plotting from a single point calculated for each composition encountered. Alternately each line of the sheaf may be drawn for an even value of entropy (or specific heat) at one temperature; and another chart or nomogram would be devised to relate gas composition to entropy (or specific heat) at one temperature.

NOMENCLATURE

α = residual volume, cc./gm.
C_p = isobaric specific heat, g.cal./gm.-°C.
d = total differential
∂ = partial differential
H = enthalpy, g.cal./gm.mol.
m = a constant, specific heat ratio, C_p/C_p'
P = pressure, atm.
R = constant for Ideal Gas Law, PV/T, $\frac{\text{cc.-atm.}}{\text{gm.mol-°K}}$
S = entropy, g.cal./gm.mol-°K
T = temperature, °K
V = volume, cc.
Δ = net change in any quantity
' = superscript denoting reference gas
μ = Joule-Thompson coefficient

Entropy Plots for Different Pressures

Figures 1 to 5 are at atmospheric pressure; similarly other constant pressures give other straight lines which, for each gas, are parallel to the one for atmospheric pressure. If

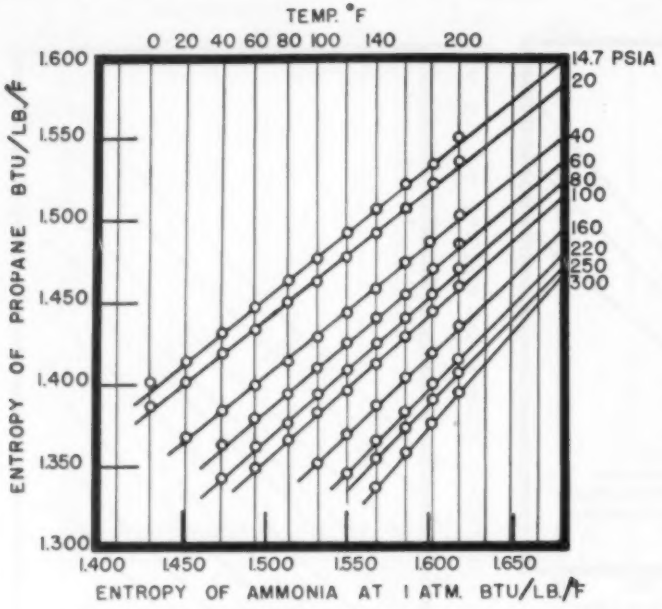


Figure 7. Entropy of Superheated Ammonia Vapor at Different Pressures.

entropies are known for a given gas at one pressure, the temperature calibration may be prepared on the horizontal axis by using the temperature—entropy data for the gas itself at this pressure to give isobars which are parallel, 45° lines.

Thus in Figure 6, on a standard piece of graph paper, temperatures are calibrated along the *X* axis corresponding to entropies for superheated steam at atmospheric pressure. The atmospheric pressure line is actually a plot of identical values against each other to give a 45° diagonal. Lines for other pressures are plotted from standard data[6]; and these are found to be parallel to the atmospheric line. A plot of entropy isobars of any gas or gas mixtures may be prepared readily when complete data are not available by using a different gas as a reference. Figure 7 shows such a plot for superheated ammonia versus superheated steam. Here also the isobars are parallel.

A complete temperature—pressure—entropy relation is thus obtained through the knowledge of one point at each pressure. Lacking the data at each pressure desired, a preliminary plot of such entropy and pressure data as are available can be made, from which single points can be picked at even pressures for the development of the complete charts. The methods of Dobratz,[2] of Stull and Mayfield,[13] and of Bennewitz and Rossner[1] may sometimes also be utilized to advantage for the calculation of entropy charts as indicated above and of enthalpy plots as indicated below.

After plots like Figures 6 and 7 are made, data may be picked off and cross-plotted as the familiar temperature—entropy diagram on regular coordinates, where this form may have any advantage due to uniform division of the horizontal, or temperature axis. Common problems solved by using one or the other form are in the determination of pressures and temperatures in gas compression cycles, nozzle efficiencies, turbo-compressor calculations, as well as numerous heating, cooling and similar calculations in separation, chemical reactions, etc.

Construction of Enthalpy

Reference Plots

An enthalpy reference plot may also be constructed as above. At constant pressure, if the enthalpy of a gas is plotted on ordinary graph paper against the enthalpy of a related gas, always at the same temperature, a straight line passing through the origin is obtained. Thus, a complete plot can be made from the enthalpy of a gas which is known at only one temperature, and the data for a reference substance. Again the ratio of the isobaric specific heats of the two gases at the same temperature, is the slope of this line. This ratio may be used instead of the single enthalpy point to define a straight line drawn at the corresponding angle through the origin. This line expresses the entire enthalpy relation against a temperature scale derived from the enthalpies of the standard substance. For practical purposes, it has been found that one line suffices, since there is no change with pressure.

This enthalpy correlation has been tested with data of Rossini[11] for diatomic gases, paraffin vapors, olefins, diolefins, and alkyl benzenes in Figures 9 through 13. In each case the reference is one of the homologous series of hydrocarbons being correlated. In none of the plots, Figures 9 through 13, does the deviation of predicted values from experimental data[11] exceed one percent. Hence, for a new gas, isobars, drawn through the origin from a single point of enthalpy data or drawn through the origin at a slope equal to the ratio of the isobaric specific heats of the two gases may be assumed to represent true values over a wide range. Plots may also be constructed for any mixture of gases, if desired, from a single value of enthalpy or of specific heat calculated from the gas analysis.

Theoretical Development

Entropy

For a gas of one or more components the total differential of entropy is defined[3] by:

$$dS = Cp\left(\frac{dT}{T}\right) - \left(\frac{\partial V}{\partial T}\right)_p dP \quad (1)$$

the terms of which are in the table of nomenclature, and the value of which at constant pressure is:

$$dS = C_p\left(\frac{dT}{T}\right) \quad (2)$$

Also, for some reference gas, of similar structural characteristics at the same pressure:

$$dS' = C_p'\left(\frac{dT}{T}\right) \quad (3)$$

Then, if Equation (2) is divided by Equation (3) (values always at the same temperature and differential entropies being above the same datum temperature):

$$\frac{dS}{dS'} = \frac{C_p}{C_p'} \quad \text{or} \quad dS = \left(\frac{Cp}{C_p'}\right) dS' \quad (4)$$

Equation (4) defines the change of entropy as a function of the change of

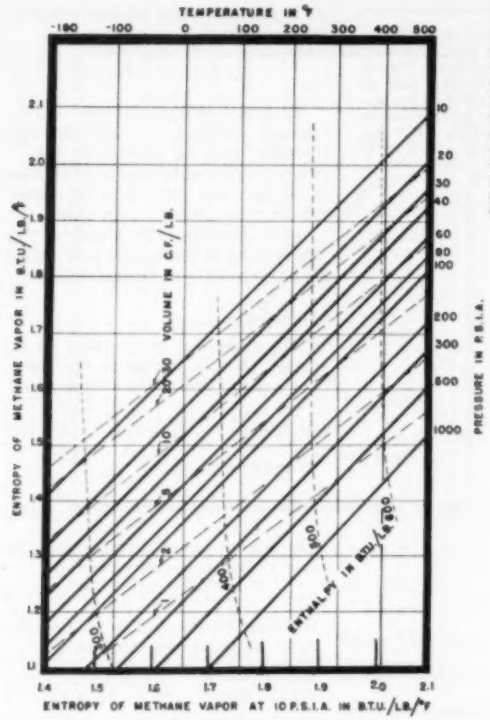

TEMPERATURE IN °F
-150 -100 0 100 200 300 400 500
ENTROPY OF METHANE VAPOR IN B.T.U./LB./°F
VOLUME IN C.F./LB.
PRESSURE IN P.S.I.A.
ENTHALPY IN B.T.U./LB.
ENTROPY OF METHANE VAPOR AT 10 P.S.I.A. IN B.T.U./LB./°F

Figure 8. Entropy of Superheated Methane. (NOTE: For additional usefulness an additional series of straight lines of constant volume are plotted and these also are straight. The corresponding lines of constant enthalpy are also plotted and these are curved slightly bowed.)

entropy of the reference gas, which in turn is a function of the temperature. Thus S′ serves as the measure of temperature.

Numerous experimental values of specific heats are available;[11] and the ratios for two gases from the same hydrocarbon series have been found to remain constant over wide temperature ranges (i.e., 80° F. to 3000° F.). If the average of specific heat ratios from several consecutive temperature increments is taken, results will be more accurate. The integrated form of Equation (4) may be preferable and is written as:

$$\Delta S = m \times \Delta S' \qquad (5)$$

where *m* is the ratio of the isobaric specific heats of the two gases. This is the equation demonstrated by the straight lines through the origin of Figures 1 to 5; it is their exact mathematical expression.

Here again the large value of this method of plotting values for the property of one substance against those of another is shown to give a constant ratio, i.e., C_p/C_p', even though C_p and C_p' are both varying (in the same direction). The same was indicated for plots of vapor pressure[7] when the reference substance method minimized the effect of decreasing values of latent heats by using the ratio of latent heats of two different substances—both decreasing. This gave a much better correlation of vapor pressures on a logarithmic plot, wherein the latent heat ratio stays constant, than the usual plot of logarithms of pressure versus a reciprocal temperature scale, which line curves, due to the decrease of the latent heat of any substance with increasing temperature.

Another useful relationship expresses the change of entropy with pressure; and at constant temperature Equation (1) becomes:

$$dS = -\left(\frac{\partial V}{\partial T}\right)_p dP \qquad (6)$$

which for ideal gases may be taken under these conditions as:

$$dS = -\left(\frac{R}{P}\right) dP \qquad (6a)$$

For real gases, the usual substitution[8] can be made:

$$dS = \left[\left(\frac{\partial \alpha}{\partial T}\right)_p - \frac{R}{P}\right] dP \qquad (7)$$

$\left(\frac{\partial \alpha}{\partial T}\right)_p$ is so small as to be negligible for practical problems under a con-

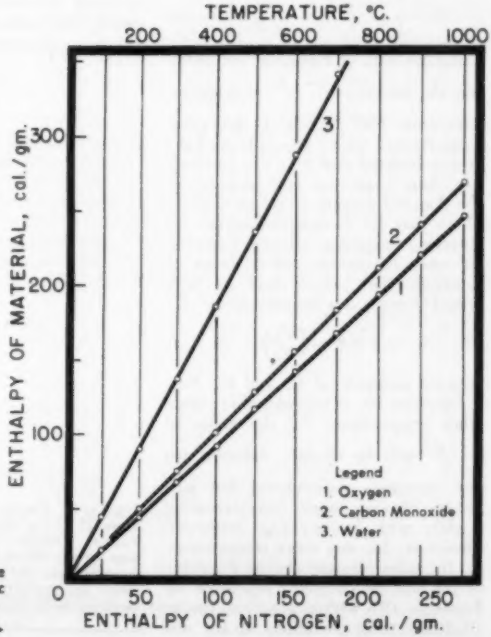


Figure 9. Enthalpy above 18° C. of Inorganic Gases.

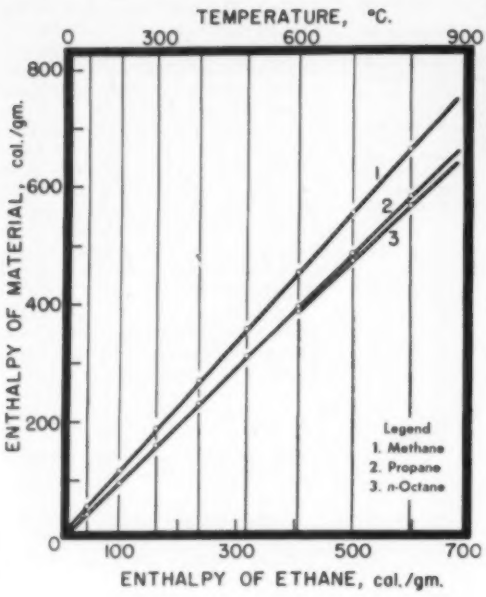


Figure 10. Enthalpy above 0° C. of Paraffin Hydrocarbon Vapors. (NOTE: The lines for ethane and for the paraffines between propane and octane are straight but too close to be drawn.)

siderable variation of temperature and pressure. This may be shown with actual values since it is equal[4] to $\frac{\alpha - \mu C_p}{T}$.

Equation (7) becomes:

$$dS = \left[\frac{\alpha - \mu C_p}{T} - \frac{R}{P}\right] dP \quad (8)$$

Using the data of Edmister[5] for methane, the values of $\frac{\alpha - \mu C_p}{T}$ at temperatures from 100° to 200° C. and pressures from 1 to 10 atmospheres have been calculated and found to be much less than 1 percent and some times less than 0.2 percent of values of R/P, which may be disregarded within engineering accuracy. Hence Equation (8) may be disregarded in favor of Equation (6a) which may be integrated to give, at a temperature of T_1:

$$\Delta S = R \ln \left(\frac{P_1}{P_2}\right) \quad (9)$$

between pressure of P_1 and P_2. Now if Equation (9) is considered for some other temperature, T_2, the value of $\frac{\alpha - \mu C_p}{T}$ will be slightly different for any pressures encountered but will always be very small, but increasing slightly with increasing pressures. Therefore, for any other temperature, for the same pressure change the value of ΔS will be correctly expressed by Equation (9) within practical limits. (Actually these deviations at any one temperature from exactitude equal $\frac{\alpha - \mu C_p}{T}$, an always positive second differential; and variations among different temperatures may be regarded as third differentials.) This may be stated that vertical distances between any two pressures lines on plots such as Figures 6 or 7 at constant temperature are equal:

$$\Delta S_{T_1} = \Delta S_{T_2} \quad (10)$$

Thus the isobars are parallel and the entropy relations for any different pressure may be established with a single experimental point by drawing a straight line parallel to the atmospheric or any other known isobar.

From Equation (9) it follows that the spacing of the isobars with regard to temperature will be logarithmic.

Enthalpy

The theoretical development for enthalpy plots is similar to the above. For a gas or one or more components:

$$dH = \left(\frac{\partial H}{\partial T}\right)_P dT + \left(\frac{\partial H}{\partial P}\right)_T dP \quad (11)$$

At constant pressure:

$$dH = \left(\frac{\partial H}{\partial T}\right)_P dT = C_P dT \quad (12)$$

The equation for the reference gas may be written in the same form.

$$dH' = C_P' dT \quad (13)$$

Dividing Equation (12) by Equation (13) always at same temperature:

$$\frac{dH}{dH'} = \frac{C_P}{C_P'} \text{ or } dH = \left(\frac{C_P}{C_P'}\right) dH' \quad (14)$$

The integrated form of Equation (14) is:

$$\Delta H = \left(\frac{C_P}{C_P'}\right) \Delta H' = m \Delta H' \quad (15)$$

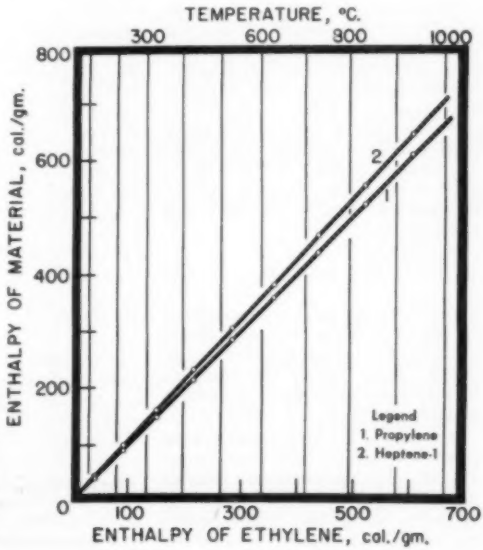


Figure 11. Enthalpy above 25° C. of Olefin Vapors. (NOTE: The lines for the olefins between propylene and heptene-1 are straight but too close to be drawn.)

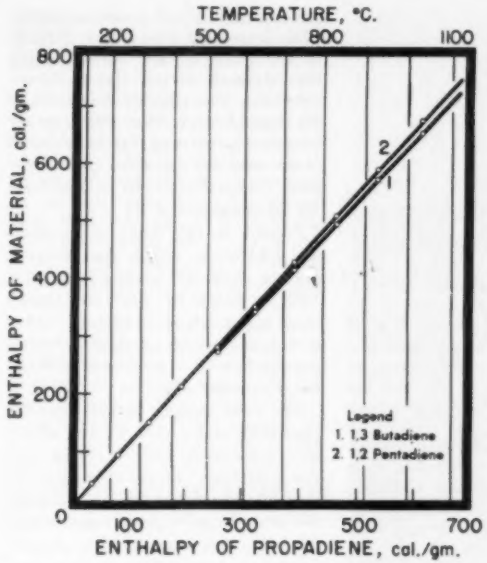


Figure 12. Enthalpy above 25° C. of Diolefin Vapors.

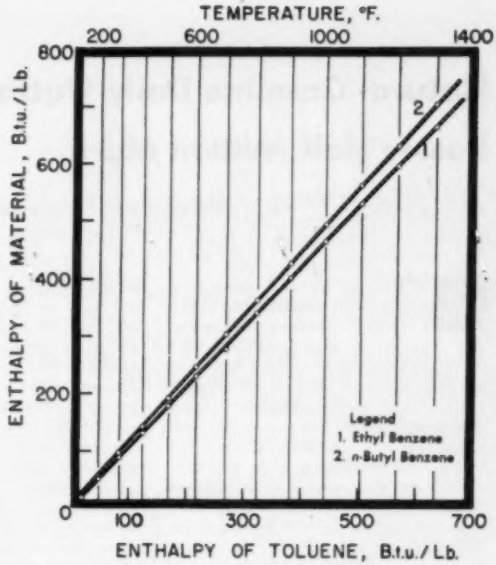


Figure 13. Enthalpy above 32° F. of Alkylbenzene Vapors. (NOTE: The line for n-propyl benzene is straight and falls between those for ethyl benzene and n-Butyl benzene.)

Like Equation (5), Equation (15) represents an isobar as a straight line with the origin as its intercept. This is verified by the straight lines through the origin in Figures 9 to 13.

As in the derivations for entropy, a relationship for the change of enthalpy with pressure at constant temperature may be developed. If Equation (11) is considered at constant temperature, it reduces to:

$$dH = \left(\frac{\partial H}{\partial P}\right)_T dP \quad \text{or}$$

$$dH = -T\left(\frac{\partial V}{\partial T}\right)_P dP + V\,dP \tag{16}$$

For a perfect gas at constant temperature, Equation (16) reduces to zero; thus there is no change of enthalpy with pressure; i.e., all isobars are represented by a single straight line passing through the origin.

Making the above substitution for $\left(\frac{\partial V}{\partial T}\right)_P$

$$dH = T\left[\frac{\alpha - \mu C_p}{T} - \frac{R}{P}\right] dP + V\,dp \tag{17}$$

The argument presented above for the relation of $\frac{\alpha - \mu C_p}{T}$ holds exactly for enthalpies as well.

Quantity Very Small

For methane, this has been shown above to be a very small quantity; hence it may be assumed to be small for any other real gas. For most purposes the single line may be used for all pressures with any gas or gas mixture; but for very precise computations, the actual correction may be computed if data are available.

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FOOTNOTE

Previous articles in this series have appeared in "Industrial and Engineering Chemistry" during 1940, 1942, 1943, 1944, 1945, 1946, 1948, 1949, 1950 and 1952; in "Chem. Met. Eng." 1940; in "Chimie & Industrie," 1948; in "Euclides" (Madrid), 1948; in "Sugar", 1948; and in PETROLEUM REFINER, 1951 and 1952.

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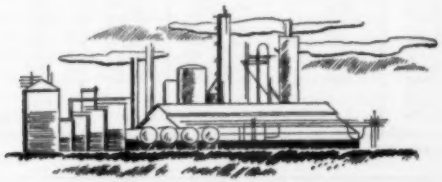


Natural Gasoline Daily Output Passes Half-Million Mark

CECIL W. SMITH, Economics Editor

PRODUCTION and processing of natural gasoline and allied products experienced a healthy gain during the past year with the daily average figure edging over the ½ million mark. Output of natural gasoline and allied products jumped 13.2 percent, the gross production having been 205,501,000 barrels or an average of 563,016 barrels per day.

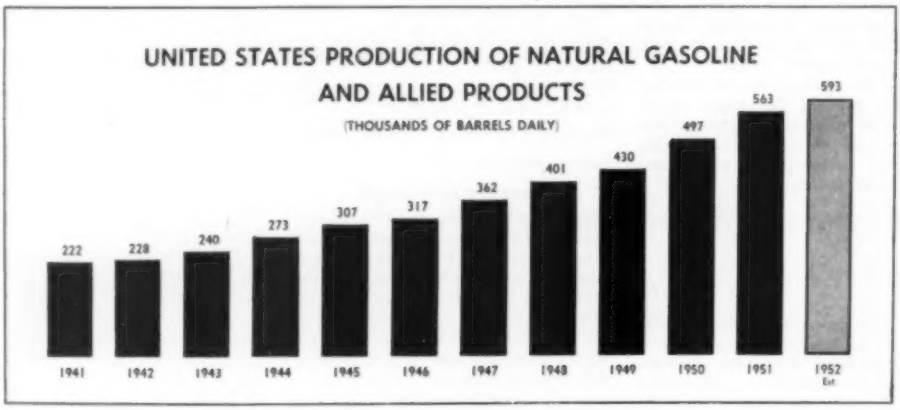
Pace in the expansion of natural gasoline facilities continued to quicken, although not at the rate reported for the previous year, 1950. The forthcoming year likely will see the output approach a daily average of 592,896 barrels. Reduced momentum in products gain is being governed by the fact that the end of World War II saw a scrimmage for allocated materials needed in the completion of proposed plant projects. By now, the expansion program has largely been completed.

International unrest will undoubtedly place additional demands upon natural gasoline producing facilities; however, the scarcity and allocation of fabricating metals will stalemate plans for expansion programs.

Statewise, Texas again copped the lead for the production of natural gasoline and allied products during 1951. Increasing from a daily average of 256,400 to 299,000 barrels during the 12-month period. Texas experienced the most significant increase in the state's history. Stemming from the increased processing facilities found in the state, the figure for 1951 represents a large slice of the total increase for the continental U. S.

Second in the count of increases was Oklahoma with a rise from an average of 40,200 barrels per day in 1950, to 46,900 for 1951. Not far behind was Louisiana, whose plants flowed an average of 61,000 barrels per day in 1951 as compared to 56,100 for the former year.

The four leading natural gasoline producing states account for almost nine-tenths of the nation's output. This group includes Texas, which contributed 53.1 percent in 1951; California, the second largest producer, with its product amounting to 14.4 percent; Louisiana owning 10.8 percent; and Oklahoma adding 8.3 percent.



(All Figures in Barrels)

YEAR	Annual Production	Daily Average	YEAR	Annual Production	Daily Average	YEAR	Annual Production	Daily Average
1918	6,727,000	18,430	1931	43,617,000	119,499	(*) Natural Gasoline and Allied Prod.		
1919	8,370,000	22,931	1932	36,281,000	99,128	1941	80,855,000	221,521
1920	9,161,000	25,029	1933	33,810,000	92,630	1942	83,222,000	228,279
1921	10,713,000	29,350	1934	36,556,000	100,154	1943	87,716,000	240,318
1922	12,044,000	32,997	1935	39,333,000	107,762	1944	100,046,000	273,350
1923	19,434,000	53,244	1936	42,770,000	116,858	1945	112,004,000	306,861
1924	22,235,000	60,751	1937	49,177,000	134,732	1946	115,739,000	317,093
1925	26,845,000	73,547	1938	51,347,000	140,677	1947	132,173,000	362,118
1926	32,455,000	88,917	1939	51,650,000	141,507	1948	146,721,000	400,877
1927	39,075,000	107,054	1940	55,700,000	152,186	1949	157,086,000	430,373
1928	43,191,000	118,009				1950	181,559,000	497,422
1929	53,183,000	145,707				1951	205,501,000	563,016
1930	52,631,000	144,194				1952 Est.	217,000,000	592,896

* Bureau began a new series covering 1941 and subsequent year, which includes cycle condensate

Liquid Recovery From Hydrocarbon Gases

T. H. ANDERSON, JR., and W. E. COLBURN
C. F. Braun & Company, Alhambra, Calif.

THE RECOVERY of liquefied petroleum gases and natural gasoline from natural gas has grown to become one of our major industries. Production has increased at a rapidly accelerating rate, with over 3 billion gallons of LPG being sold last year.

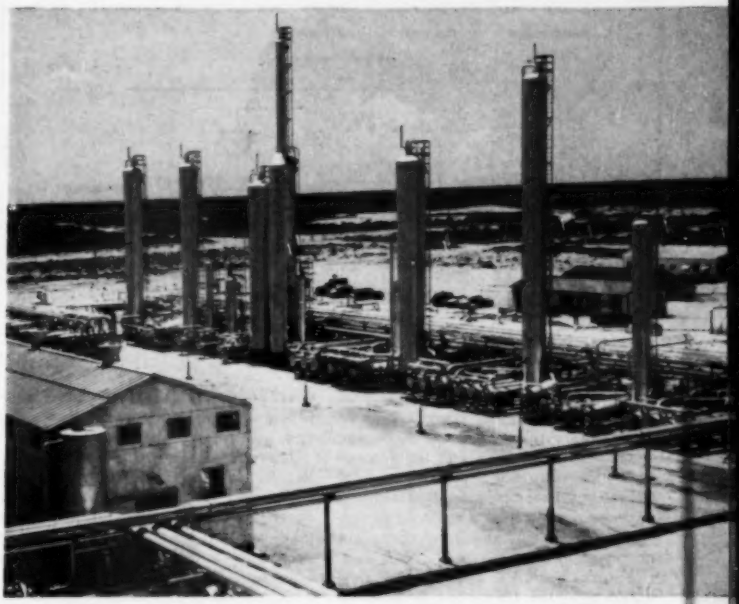
The basic processes available for recovery of liquids from wet gas include adsorption, condensation, gas fractionation, and absorption. The selection of the optimum recovery process depends chiefly upon the feed gas, the desired recovery, and the dry gas specifications.

A complete example case is developed to illustrate how these factors are weighed in the selection of the most economical processing scheme.
This paper was originally presented before the 26th Annual Meeting of the California Natural Gasoline Association, Los Angeles, October 4-5, 1951.

GAS containing liquid fractions has been a source of revenue since the beginning of the petroleum industry. In the early days, kerosene was the industry's main product. Gasoline was a by-product. Gases were flared as a general rule. But the condensate from the gas-lines found its way into sales outlets of one form or another. The liquid was worth more than the vapor. This economic drive continues to this day. It is this drive that has dotted our oil fields and refineries with gasoline-recovery plants.

The automobile switched the oil industry's emphasis from kerosine to gasoline. Real money was to be made salvaging the condensate from the gas-lines and recovering the gasoline fractions from wet gas. The horseless carriage widened the gap between the value of gasoline as liquid and gasoline as gas. This price-advantage launched the natural gasoline industry and sustains it today.

Early gas-recovery plants were built to recover a 12 to 26-pound Reid Vapor Pressure product. Liquid butanes and propanes were revaporized. Again the value of liquid over vapor was felt. About 1922, the so-called bottled gases found markets for these surplus liquids. The liquefied petroleum gas industry came into being. It started with 223,000 gallons of bottled gas sold in 1922. Last year, the industry sold 3 1/3 billion gallons of LPG.



Typical Absorption Plant. From left to right the columns are: hydrogen sulfide absorber and regenerator, dehydrator absorber and regenerator, main absorber, fatoil fractionator, stripper, depropanizer, deethanizer, and debutanizer.

In the early days of the industry, not much was known of the behavior of hydrocarbons. The first plants were designed with more horse-sense and dead-reckoning than technical data. But our scientific knowledge of the light hydrocarbons has grown with the industry. Now the process-engineer has the tools to predict accurately the performance of any part of his plant.

This wealth of scientific knowledge has taxed the ingenuity of the engineer to squeeze the most out of his chosen recovery-process. But it is not within the scope of this paper to discuss the variations that can be used to increase recovery or improve performance. First, the engineer must select the basic cycle he will use. It is this first step that we treat in this paper.

There are four basic ways to recover liquids from wet gas—adsorption, condensation, gas fractionation, and absorption—each of which will be discussed.

Adsorption

The use of a solid adsorbent is a well-known method for removal of

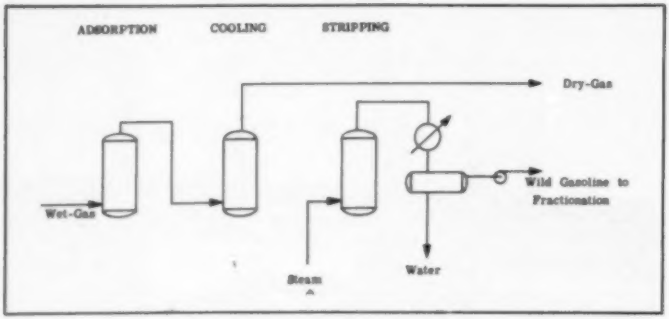


Figure 1. Adsorption-Cycle.

components from vapors. This process was used in some of the early gasoline-plants. Activated coke was the usual adsorbent. However, the adsorpbent picks up only a part of its total weight before it becomes saturated and must be regenerated. Thus a large volume of adsorbent and batch-operation are necessary.

Figure 1 shows a simplified flow diagram of the adsorption process. In the first step wet gas goes through a bed of activated coke. The dry gas goes to the second step. Here the gas cools a bed of hot stripped coke. In the third step adsorbed gasoline is stripped by turning steam into the coke bed. The gasoline leaves as vapor. It is condensed, separated from the water, and sent on for fractionation.

Let's look at an adsorbent plant for 30,000 gallons per day of liquid-recovery. This is some 150,000 pounds per day. According to Perry's Chemical Engineers' Handbook, coke will adsorb about 15 pounds of gasoline per 100 pounds of coke. At four hours per step, we would need 250 tons of coke. It is easy to see why these coke plants disappeared from the scene long ago.

However, the adsorbent cycle is selective. By proper control, the desired component can be picked out and recovered. The Hypersorption process takes advantage of this property. It overcomes another drawback, batch operation, by the use of a moving bed. This process is in commercial use for ethylene recovery. So far we have seen no reports on the commercial use of this process for propane and heavier fractions.

Until further refinements are developed, the adsorption cycle should be neglected by the process-engineer. One exception—the case of ethane or ethylene recovery. In such instances, the Hypersorption process may prove attractive. But since this process is a specialized cycle, we have not considered it in the general case of liquid-recovery from hydrocarbon gases.

Condensate Fractionation

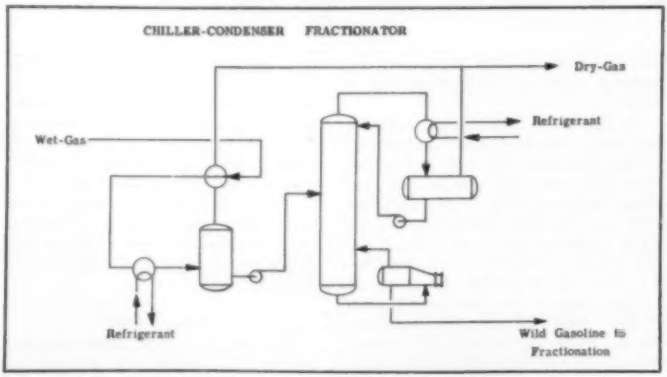
Condensate was the first method of recovery—the drips from the gas-lines. These drips were wild and quickly evaporated at reduced pressure. Compression and condensation increased the yield. Subsequent rectification stabilized the product. But as long as the dry gas was separated directly from the condensate, some gasoline vapors were lost.

Where rich gases are available, the compression condensation cycle is often attractive. Only one fractionator is required. The gas off the condensate is small and the gasoline losses approach a negligible quantity.

Figure 2 shows a simplified flow diagram of a condensate fractionator. Here the wet gas is cooled, first by heat-exchange with the dry gas, then by refrigeration. The condensate separates in the accumulator and is pumped to the fractionator—a conventional non-condensing rectifier except refrigerant is used to condense top reflux. The top product goes direct to dry gas. The bottoms spill down into the fractionation system.

This cycle gives a constant-composition feed to the fractionator. A boon to the operators where widely fluctuating gas-rates are encountered. However, where refrigeration is necessary for desired recovery, hydrates are a problem. In such cases, drying of the feed is a must.

Figure 2. Condensate-Fractionator.



Gas Fractionation

The loss of gasoline in the condensate-fractionation cycle challenged the process-engineer. He came back with gas fractionation. Here he compresses and cools the wet gas, and then feeds the mixture to a single fractionating-column. This column splits the wet gas on a key component. The light ends go out as dry gas. All the heavies come out in the bottoms liquid and spill down to the fractionators.

Figure 3 shows a simplified flow diagram of this process. The compressed and cooled wet gas leaves the dehydrating unit. The gas is cooled by exchange with dry gas off the reflux drum. The cooled mixture goes direct to the fractionating-column. This is a conventional non-condensing rectifier. The overhead is cooled by refrigeration. All the condensed liquid is pumped back as reflux. The uncondensed vapors go off as the dry-gas product. A conventional steam-reboiler is used on the bottoms. The bottoms liquid spills down to the fractionators.

Once again the engineer found himself limited to a relatively rich gas. He had to operate the column below the critical pressure of the bottoms. And he had to have enough pressure

or a sufficiently low temperature in the reflux drum to have liquid in equilibrium with the dry gas. Often this required hydrate-forming temperatures, and in such cases, drying of the feed is necessary.

Absorption

The absorption-cycle gave the engineer the answer to high pressures and low temperatures. Using absorption oil, the designer could operate above hydrate-forming temperatures. Pressures could be adjusted to suit the specific plant-conditions. Variation of the oil rate was all that was necessary to obtain the desired recovery.

Here was a cycle that could operate under any plant-conditions. This is the cycle that became and still is the backbone of the vapor-recovery industry. But it was no Utopia.

The absorption oil picked up every component in the wet gas. It took two stills to strip the oil. The primary still-pressure was a delicate balance to keep recycle vapors down, and excessive light ends out of the fractionating system. Low absorber-pressures took high oil-rates. High absorber-pressures cut the oil-rate but hiked the recycle. The engineer used vent tanks and reabsorbers to get the recycle under control. About ten years ago, he came up with the fatoil fractionator. This column enabled him to kill the recycle and use a single still. But no matter how the engineer struggled, he still had to have at least three columns and a sizeable oil circulation rate to make his recovery.

A simple three-column absorption system is shown in Figure 4. The absorber removes the gasoline and LPG from the wet gas. The fatoil fractionator takes the dry-gas fractions out of the fatoil. The overhead gas usually goes to plant fuel. Any excess is recompressed to dry gas. The stabilized fatoil goes to the stripper. Heat and steam are used to split the gasoline out of the fatoil. Lean oil comes out the bottom of the stripper. Steam and recovered fractions out the top. They are condensed. The water is separated and drawn off in the accumulator. The wild gasoline is pumped to the fractionators.

Choice of Cycle

As usual, we find several features we like and several things we would prefer to avoid in each cycle. The engineer must first select the best cycle for his recovery; then work out the refinements. If he works up all cycles with refinements, he finds himself in an endless task. He must choose at the start. And we confine our discussion to the basic factors he needs to make his selection.

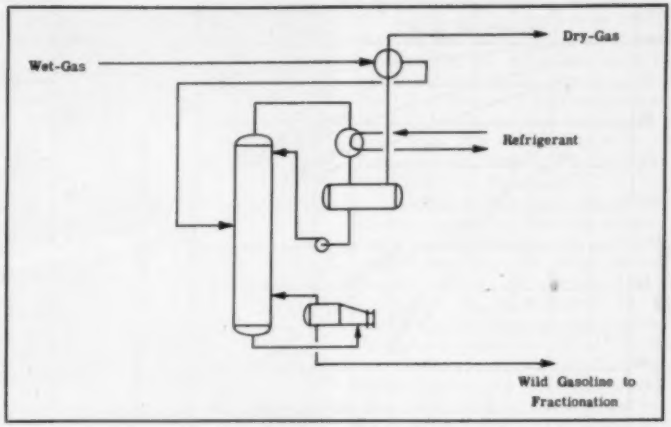


Figure 3. Gas-Fractionator.

Feed rate affects the size of equipment. Variations in rate may temper his selection. But such factors affect all cycles in about equal proportions. The richness of feed and the entering pressure levels are basic factors which help make one cycle more economical than another.

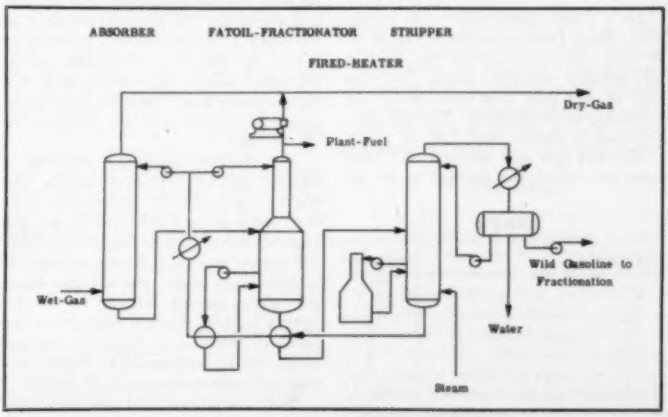
The same recovery makes the same raw gasoline. The number of liquid products will set the number of columns in the fractionating section. Thus the fractionation section will usually be the same for all cycles. But the percent recovery makes the big difference.

Dry-gas conditions at plant-limits play a major role. The pipe line or repressuring pressure usually sets the maximum pressure in the plant. The exception is in refinery gasplants. There, tail-gas pressures are so low the engineer must use higher pressures to keep equipment sizes within bounds.

Pipe lines have had their troubles with hydrates. If the tail-gas is sold, it often has to meet a low dewpoint. In such cases, drying equipment is required and the engineer can use temperatures down to the dewpoint. Pressure maintenance, cycling and refinery gasplants as a rule use the dry gas before it can be chilled to hydrate-forming temperatures. In these plants, the engineer must keep his temperatures out of hydrate zones or save enough to justify a drying system.

Utilities are not a problem at this stage of the process-design. Utility levels can be adjusted within reasonable limits without materially affecting the economics of the design. Limiting

Figure 4. Absorption-Cycle.



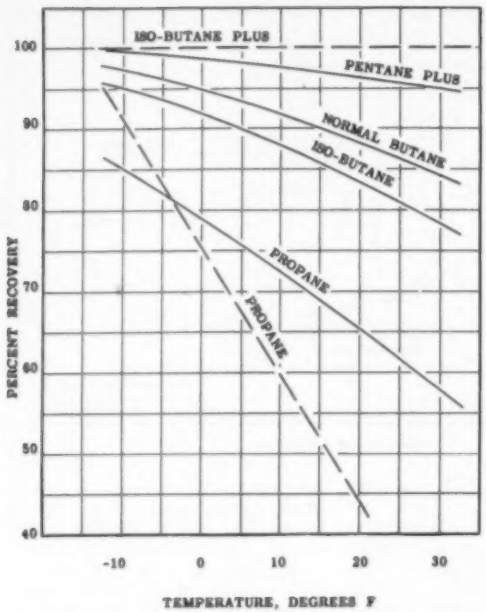


Figure 5. Percent Recovery vs. Temperature. Solid lines indicate condensate-fractionator whereas broken lines indicate gas fractionator.

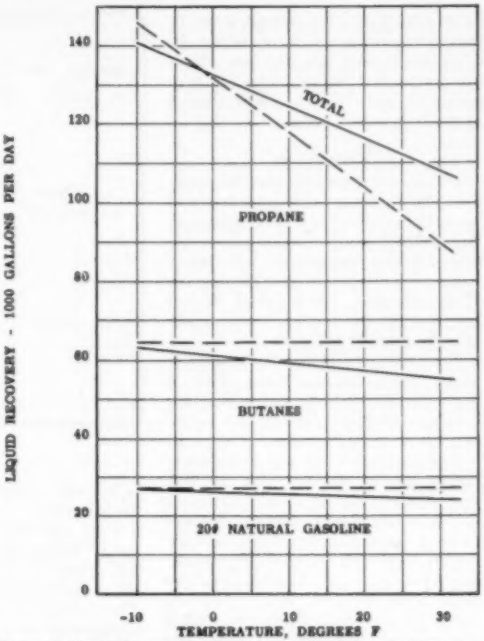


Figure 6. Liquid Recovery vs. Temperature. Solid lines indicate condensate-fractionator whereas broken lines indicate gas fractionator.

cooling-water temperature is the one fixed item. The engineer must stay within this limit or be prepared to pay for refrigeration.

We have three factors to consider when selecting our basic cycle: 1) the feed gas—its composition, rate, and entering pressure; 2) the recovery or range of recovery desired; and 3) the dry gas—its exit pressure and dewpoint. And we keep our eye on the cooling-water temperature.

Example

Let's follow the engineer as he applies these factors in the selection of a cycle. In our example the feed is 24 million standard cubic feet per day of wet gas. The pressure at the plot-edge is atmospheric. The gas composition is shown in Table A.

The dry gas will be sold, the sales contract calling for the gas to be delivered at 500 psig with a —10° F. dewpoint. LPG propane, butanes, and 20-RVP gasoline are the liquid products, with 75-percent maximum propane-recovery to meet winter demands. Cooling-water temperature for design is 70° F.

TABLE A

COMPOSITION	Mol Percent
C_1	52.5
C_2	25.8
C_3	13.8
iC_4	2.0
nC_4	3.7
iC_5	.7
nC_5	.6
C_6+	.9
	100.0

With these conditions, the process falls into four steps: 1) compression, 2) drying, 3) liquid-recovery, and 4) fractionation.

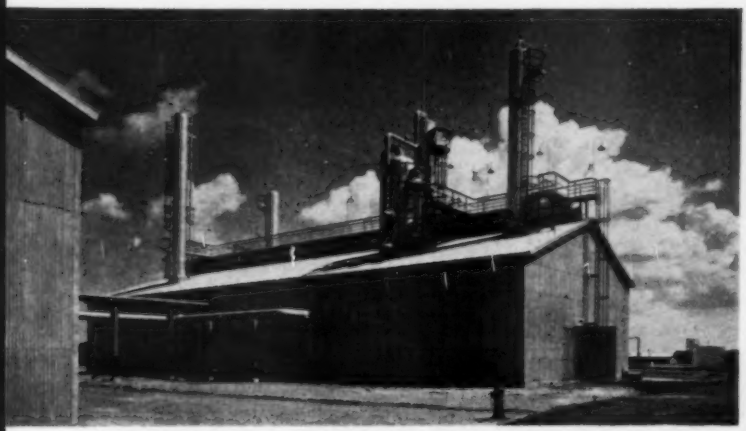
The compression section must lift the gas to about 535 psig. This allows 35 psig for pressure-drop and control and meets the 500-psig requirement at the plant fence. Since this pressure is below the 800-psig retrograde point, all cycles will be more efficient at this top pressure level. Thus the same compression section will be common to all cycles.

The dry-gas dewpoint requires a drying section. Pressure assists the drying, so the drying section goes after the compressors. Either wet or dry gas can be dried. There would be little difference in either drying section. It is preferable to dry the wet gas, since this gives greater latitude in the recovery process. Then temperatures can be used down to the dewpoint without encountering hydrates. The drying section becomes common to all cycles.

Both condensate and gas fractionation would deliver an ethane-free liquid to the fractionation section. An absorption section using a fatoil fractionator for 75 percent propane recovery would also deliver an essentially ethane-free raw gasoline to the fractionation section. Thus we can expect the same raw-gasoline feed from any cycle and the engineer can eliminate the fractionation section from considerations affecting his choice of cycle.

By these quick evaluations, the engineer finds he can focus his attention on the recovery section alone. But he must stay within pressure and temperature limits. Five hundred psig is his pressure limit, and with 70° F. cooling-water, 80° F. is his temperature limit without refrigeration. With refrigeration 0° F. is a reasonable minimum temperature with a —10° F. dewpoint. Any increased pressure or lower temperature would require extra equipment in another section. If the cycle is not economical within these temperature- and pressure-limits, the chances are practically nil that it could both justify additional equipment and become the optimum cycle at the same time. It is a good rule that the engineer should not look outside his limits for the optimum cycle.

The easiest cycle to check is the compression-condensation cycle. All



Typical Gas Fractionation Plant. The equipment is housed for 40° F.-below-zero weather. From left to right the columns are: depropanizer, debutanizer, gas fractionator, dehydrator absorber, and dehydrator regenerator.

that is necessary is a check on recovery at maximum pressure and minimum temperature—525 psig and 0° F. in our case. Under these conditions, some 43 mol percent condenses. This gives about 79-percent propane-recovery after losses in the condensate fractionator, 94-percent butane-recovery, and 99-percent pentanes-plus.

For gas fractionation the engineer checks equilibrium in the reflux drum between the dry gas and the reflux. Again limiting pressures and temperatures are used. At 525 psig and 0° F., propane-recovery is 75 percent—isobutane and heavier, 100 percent. The bottoms critical pressure is about 650 psig. This cycle meets requirements.

The next step is to check the absorption cycle. Here the engineer uses 525-psig main absorber pressure and 80° F. leanoil. Refrigeration and intercooling are not considered because they are refinements. As such they do not affect the selection of the basic recovery process. Fat oil fractionator and still-pressures are established, and the oil rate calculated for 75-percent propane recovery—340 gpm.

Often this initial check eliminates one or two processes at the start. In our case all are tenable. But how do they compare in cost and utility-consumption? The engineer rough-sizes and rough-prices each cycle. He approximates the fuel and steam requirements. For a common denominator we convert all heat to fuel. This shows the gross heat input. Since the feed and products enter and leave at essentially the same temperature, the fuel requirement indicates the relative cooling load.

Table 1 shows the approximate costs, fuel requirements, and compressor horsepower. Plant costs are total for the plant ready to operate but less operating supplies, chemicals, and the like. The total fuel figure includes direct fired fuel, steam converted to fuel at 80-percent efficiency and compressor fuel both for gas and refrigeration. Compressor horsepower is total for gas-compression and refrigeration. The absorption plant would cost around $3¾ million and either fractionator around $3½ million. Comparing utilities, the total fuel for the absorption plant would be 2½ million standard cubic feet per day. But only 2 million standard cubic feet per day for the fractionators. Some 6000 horsepower are required for gas-compression. Refrigeration requirements raise the horsepower to 7300 for condensate fractionation and 6900 for gas fractionation. The gas and condensate fractionators are a standoff. They run a shade under the absorption plant in capital investment and some 20 percent under in fuel requirements.

Figure 5 shows the variation in percent recovery with temperature for the gas and condensate fractionators. The temperature shown refers to the lowest temperature in the unit. In the condensate fractionator it occurs at the outlet of the condensate chiller. And in the reflux drum on the gas fractionator. The solid lines show the condensate-fractionator recovery. With rising temperature propane-recovery falls off at a good rate. Butane recoveries drop, but not as fast and pentanes-plus fall slightly. This is typical for condensate fractionators.

TABLE 1

	Rough Price	Approximate Fuel Consumption MSCFD	Approximate Compressor Horsepower BHP
Absorption	$3,750,000	2500	6000
Condensate-Fractionation	3,500,000	2000	7300
Gas-Fractionation	3,500,000	2000	6900

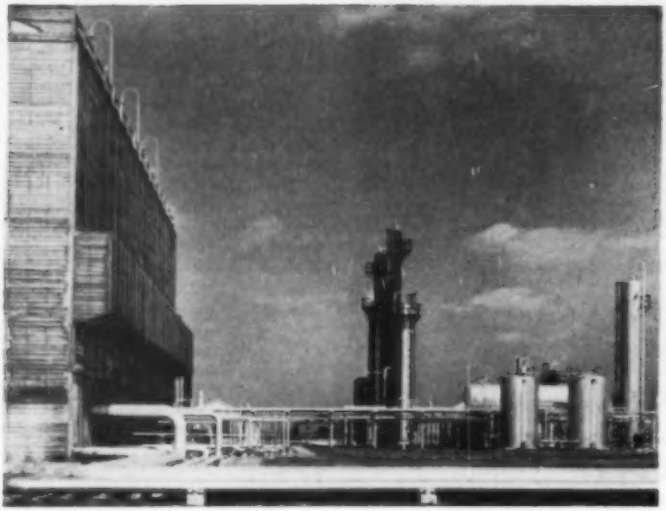
The broken lines show the gas-fractionator recoveries. Here the propane-recovery falls rapidly with increasing temperature. But the isobutane and heavier stay at 100 percent. This is typical of gas fractionators. In our case, the reflux drum temperature sets the propane-recovery. It is flexible over a wide range without disturbing the isobutane and heavier recovery. This fits in nicely with a seasonal propane demand. But how does this look in terms of gallons produced?

The total gallons produced per day by the gas and condensate fractionators is shown in Figure 6. Again the solid lines show the condensate recovery. The broken lines the gas-fractionator recovery. At 0° F. both the condensate and the gas fractionator produce the same total gallons. The condensate fractionator produces more propane, less butanes, and a little less gasoline than the gas fractionator. But the butanes and gasoline are worth more than propane. Also the propane demand in our case is seasonal. During the summer the condensate fractionator has to condense the propane to hold a high butane and gasoline recovery. The gas fractionator can reject propane by increasing the reflux temperature. No butanes or gasoline are lost and the refrigeration load is lightened when cooling-water conditions are most adverse.

The economics point to the gas-fractionation process for these conditions. The first cost is slightly under the absorption cycle. With less fuel there are lower utility costs. There is no loss of butanes and heavier. The propane recovery can be varied widely without loss of butanes and gasoline. In operation we have a single column instead of three to make our liquid recovery.

Conclusion

It is not the purpose of this paper to imply that the absorption cycle is obsolete. Far from it. A small change in a key condition could make absorption the selection. Our purpose is to show that the comparison of recovery processes is not complicated. The process-engineer by using the proper data can quickly select his recovery process and then proceed with his detailed designs in confidence.



The cooling water system at Plymouth Oil Company is considered of equal importance with the other phases of the processing operation.

THE WELDER Plant of the Plymouth Oil Company has a tough water problem—and a solution for it!

The water supply there, as in numerous other plants in this area, is of such a nature that it presents a serious problem to the plant operator. This type of water, without proper treatment, could cause, in time, a shutdown of the plant with the resultant loss in production of finished products. If it remained untreated for a period of time, it could also cause replacement of much valuable equipment.

By careful and patient study, however, the management converted a major headache into a simple operating routine. As a result, every foreseeable possibility of a shutdown caused by the water system, has been eliminated.

Tough Water Control Problems Solved at Welder Plant

M. C. FORBES
Aquatrol, Inc., Houston

THE Plymouth Welder plant, located near Sinton, Texas, is producing each day 15,000 gallons of liquefied petroleum gases, 30,000 gallons of natural gasoline and 30,000 gallons of motor fuel, leaded and unleaded. Feed stocks are the rich gas, distillate and crude from the Plymouth and Rooke fields.

The water treatment problems at Plymouth and their solutions are so similar to those of many other natural gasoline and recycling plants in the Southwest, that a detailed review may prove valuable. Scale formation and corrosion are the main problems that arise from the use of water in the cooling system and boilers.

The cooling system, which consists of two induced-draft cooling towers and two fan-cooled radiator units, dissipates the heat release to the jacket water from six compressors, three generators and engine-driven pumps totalling over 3000 hp., as well as the condensing and cooling of the process streams. Such a heat load requires a cooling water circulation rate of approximately 6000 gpm. One 2500-hp. compressor is cooled by the two radiator units.

The variety of heat exchanger equipment and the wide range of temperatures (170° to more than 600° F.) are major contributors to the scale formation problem.

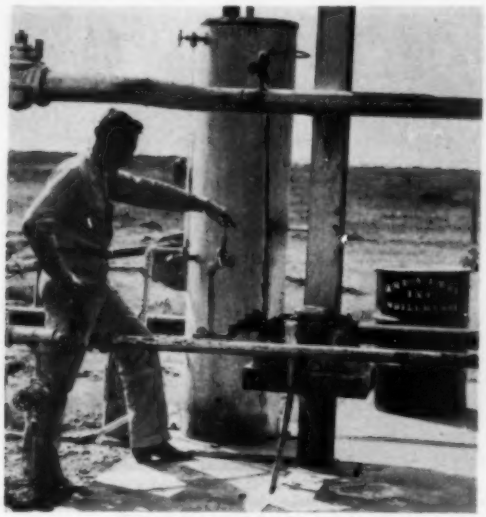
The water used as makeup for the cooling towers and boilers is obtained from three wells. Two of the wells were completed in a sand at 380 feet below ground level, and one, the No. 3 well, was completed at 530 feet. The water is produced from a seven-inch casing at the rate of approximately 125 gpm for each well. Both water sands are composed of very fine-grain structures.

The oldest well has been in service more than six years, while the newest well is only four years old. There has been no appreciable drop in water level during the lives of these wells, for the requirements of the plant are small in comparison with the sand capacities, and there are no other large withdrawals near the plant.

The plant's requirements for water are much less than the combined capacity of all three wells, so it is usual to draw from only two at a time, with the third well held in reserve. This allows sufficient capacity for emergency operation and makes it possible to service any one of the wells in an orderly manner.

The chemical content of the water from all three wells is similar, although the No. 3 well, which is produced from the deeper sand, contains approximately 40 percent more dissolved solids than the other two. All waters are fairly high in total dissolved solids, composed primarily of sodium chloride, and sodium bicarbonate. There is only a small amount of sulfate in these waters; and the silica is slightly lower than average for waters of this type. These waters are quite soft, containing only a small quantity of calcium and but little more than a trace of magnesium.

Table 1 shows the composition of these waters at the present time. Notice that the water in the lower strata shows a considerable increase in chloride and in bicarbonate. Notice also that this water fails to show even the small quantity of sulfate present in the shallow waters. Silica and hardness values, however, are not appreciably different



Continuous chemical addition adjusted by frequent laboratory analyses has provided good control for the boiler treatment at Plymouth.

from the water drawn from the other two wells.

The low hardness in these waters indicates that they should be quite unsaturated with respect to calcium carbonate, and therefore, in the natural state, would be expected to be quite corrosive. This is borne out by the fact that all three of these waters have stability indices* in the neighborhood of 8.5.

Despite the fact that these waters are quite unsaturated as they issue from the well at atmospheric temperatures, the high bicarbonate content causes them to have a high stability index-temperature coefficient. Therefore, these waters cannot be used in cooling equipment where any degree of heating and concentration take place without the formation of large quantities of scale.

The prediction from the stability index was borne out in the early operation of the plant, when it was found that the water, as produced from the wells, was mildly corrosive to the piping and tanks. And yet, it was found extremely scale forming when used in the cooling system, even though evaporation in the cooling system had concentrated the solids in the cooling water hardly at all.

* The stability index is a reliable indication of the relative degree of calcium carbonate saturation for a given water. The index value is governed by the alkalinity, pH, total solids, calcium content and temperature of the water. When values of the index are below the range 5.8-6.5 the water are supersaturated with calcium carbonate and will deposit calcium carbonate scale on heat exchange equipment. When the values of the index are over 5.8-6.5, the water is usually corrosive rather than scale forming.

Analyses of waters from these wells over the past four or five years indicate little or no change of the water composition with time. Most of the older analyses, however, reflected unusually high silica concentrations in this water; the lowest showed 33 ppm and the highest 89 ppm. Since these values seemed to reflect an unusual condition, it was decided to sample this water in special plastic containers to prevent silica contamination during the transportation of the water sample to the laboratory. When these precautions were taken, it was found that the silica concentration in the water was in the range of 20 ppm only, instead of 33-89 ppm as had been reported in the average of most of the other analyses. This factor is very important, since in this case, as in most others, the silica concentration is one of the limiting factors in the utilization of the water.

TABLE 1

Water Analyses, Raw Well Water, Plymouth Oil Company, Sinton, Texas

(Samples Taken August 9, 1951)

Well No.	1	2	3
Depth—Feet	380	380	530
Ion Concentrations, ppm.:			
Bicarbonate (HCO_3)	381	371	429
Chloride (Cl)	324	284	510
Sulfate (SO_4)	65	71	0
Silica (SiO_2)	18	18	19
Calcium (Ca)	6	7	7
Magnesium (Mg)	3	3	1
Sodium (Na)	372	343	483
Total Dissolved Solids, ppm	1169	1097	1449
pH	7.9	7.9	7.5
Sp. Cond. (Micromhos)	1661	1540	2160
Phen. Alkalinity ($CaCO_3$), ppm	0	0	0
Total Alkalinity ($CaCO_3$), ppm	312	304	352
Total Hardness ($CaCO_3$), ppm	28	32	24
Stability Index (80° F.)	8.42	8.36	8.68

Cooling Water Treatment

Five problems must be considered in using water for cooling purposes:

1) The water must not be so scale-forming that it appreciably lowers the heat transfer capacity of cooling equipment, or to cause production losses through unscheduled shutdowns for equipment cleaning.

2) The water must not be so corrosive to ferrous metals and copper alloys as to shorten the life of the equipment, or to cause production losses by shutdowns for repairs that would otherwise be unnecessary, or to cause corrosion products which could create a secondary fouling problem.

3) The presence of microbiological organisms in the water must be so controlled that heat transfer and the flow of water are unimpeded, and that excessive time is not necessary for equipment cleaning to obtain a free flow of water and heat transfer.

4) The treatment should be so arranged that an absolute minimum amount of water is discharged to waste, since such waste water places an undue strain on the water supply source, and since such waste water is also the major source-of-loss of water treating chemicals.

5) The cost of the chemical treatment to secure these results must be less than the profits derived from increased production and decreased maintenance costs.

To meet all of these conditions, the first problem is that of setting the maximum allowable concentration ratio. The concentration ratio is the ratio of the dissolved solids in the cooling water to the dissolved solids in the makeup water. This ratio is affected by the amount of water that has been removed from the system by evaporation. If the concentration ratio is too low, water which could be safely evaporated is being removed as blowdown either deliberately or as leakage. If the ratio is too high, the salts in the water are being concentrated too much and precipitation in the form of scale or sludge will take place. The water should be concentrated as much as possible, to prevent excessive blowdown to the waste-disposal system.

The limiting concentration ratio is dependent on the solubility of the various materials in the water under treatment. As this particular water comes from the ground, its maximum allowable concentration ratio is governed by the solubility of calcium carbonate as shown by the stability index.

Calculation indicates that even doubling the concentration without treatment would cause scale formation from this water. By the use of a polymerized phosphate, this concentration may be increased somewhat, but the maximum allowable concentration ratio from the viewpoint of calcium carbonate solubility, can best be obtained by destroying a part of the bicarbonate with sulfuric acid. As more and more of the bicarbonate is replaced by sulfate, and as the calcium ions in the water become more concentrated, the solubility limit of calcium sulfate will be rapidly approached. If the calcium sulfate solubility does not limit the addition of sulfuric acid, the water can be stabilized to any desired point until the silica concentration becomes limiting.

Solubility calculations on calcium carbonate indicate that this water, with proper alkalinity control, can be concentrated at least 30 times before calcium carbonate deposition will occur. However, the calcium sulfate solubility indicates that calcium sulfate formation will begin when this water has been concentrated approximately 14 to 15 times. These figures are academic, however, and serve only to indicate that the water can be adequately stabilized as far as necessary, for the silica content limits the concentration of this water to approximately ten times at most.

It should be noted that there are no hard-and-fast limits for any of these solubility criteria, since the type of equipment, or the presence of small quantities of organic materials in the water, can modify these limits greatly.

The maximum solubility of calcium carbonate can be accurately predicted for a given alkalinity, and total solids concentration, by the use of the stability index. The calcium sulfate solubility can be calculated by the usual solubility product for this material.

The silica limit is an empirical one which is usually set at approximately 200 ppm. Though some systems operate at silica concentrations considerably in excess of this figure, it is known that a majority of water systems will have difficulty with silica scale formation if this value is exceeded. Also, this silica limit used here is very near the true solubility of silicic acid as reported in the literature. With solubility determined, the next problem to be solved is that of scale formation.

Close cooperation between the chemist (Arlan Maley, left) and the resident engineer (Bob Johnson, right) is the basis of good water treatment at Plymouth.

Scale control is usually done best by means of sulfuric acid addition for control of the stability index. In cases where the use of sulfuric acid is not desirable because of high sulfate concentration, or where the plant management objects, scale can often be controlled by use of colloid-phosphate treatment alone.

In some cases, as in the water at the Plymouth plant, the use of both acid and a colloid-phosphate treatment is desirable. A treatment containing high colloid and low phosphate content is frequently required where exposed atmospheric sections are encountered with water distribution that allows alternate wetting and drying of the heat transfer surfaces. Where alternate wetting and drying exists, it is inevitable that the maximum allowable concentration ratio will be exceeded at the points where the drying occurs. When the concentration becomes excessive and the dissolved material in the water is precipitated, the colloid will maintain the precipitate in a semi-fluid sludge form that can be washed off at the next wetting. Without the colloid, the precipitate would bake on as scale.

In the case of the Plymouth plant, it was thought desirable to control the alkalinity in the basin within the range of 100-150 ppm and to use an efficient organic colloidal dispersion containing a small amount of polymerized phosphate to provide both stabilization and sludge conditioning.

Whenever scale control is practiced in a cooling water system to keep the heat transfer surfaces free for their maximum efficiency, it is usually found that the bare metal surfaces are subjected to rapid and intense corrosion. This corrosion is the result of small electrolytic cells set up along the surface of the metal by impurities in the metal, electro-thermal currents set up by differences in temperature, and electro-chemical currents set up by differences in composition of the cooling water.

Corrosion in cooling systems can be prevented by the use of corrosion resisting alloys, by locally applied surface coatings such as corrosion resistant paints, or by the treatment of the cooling water itself.

The use of corrosion resistant alloys is, in most cases, uneconomical when compared to the other treatments. Surface coatings are not often used because they are difficult to apply properly, and are uneconomical. Most such coatings interfere with heat transfer.

The economical and customary approach to the problem of corrosion caused by cooling water, is the treatment of the cooling water itself with a corrosion inhibitor to prevent the function of the electrolytic cells causing the corrosion.

There are a number of treatments on the market which approach the problem from this angle, and four of them had to be tried before a successful application was found at the Plymouth plant.

When operation was first started at this plant, no treatment was used in the cooling water, and a light layer of scale was laid down. It became evident that if efficient heat transfer was to be maintained, water treatment was necessary. At first, corrosion was no problem because the metal surfaces were protected by the light scale layer, but it was realized that when this protection was eliminated, a corrosion inhibitor would also be needed.

The initial treatment employed a chromium-type corrosion inhibitor combined with a polyphosphate-colloid scale inhibitor. It was found that the corrosion inhibitor was not needed, however, for the scale inhibitor did not reduce the rate of scale formation enough to allow the metal to lose its protective deposit. A second trial, using a similar treatment, was tried, and again scale prevention was not satisfactory. An effort was then made to control water conditions by the use of zinc hydrosulfite for corrosion control, and an organic scale inhibitor. This treatment did not work because calcium sulfite precipitated and increased the rate of scale formation, rather than decreasing it.

Finally, about two years ago, a cathanodic corrosion inhibitor and a scale control method, employing a phosphate-organic with sulfuric acid for alkalinity control, was employed. Since that time, little or no additional scale has been formed, and no additional corrosion has been noted in the circulating system.

Boiler Water Treatment

Shortly after plant operations started, scale formation in the boilers made it mandatory that some treatment be adopted for the prevention of scale. The first experiment in boiler water treatment was tried with an organic-phosphate mixture; and although scale formation in the boiler was changed in character, it was still found to be present. The original scale was largely calcium carbonate, and after treatment it contained considerable magnesium phosphate.

Thereupon, another organic phosphate mixture of a slightly different type was used. Oxygen corrosion on the fusable plugs was then noted; and again scale formation, though different, was quite a problem. The scale in this second case was largely calcium carbonate with a considerable quantity of silica in it.

The result of these two trials indicated that while the treatments used were essentially sound, completely satisfactory treatment had not yet been found. Consequently, a third phosphate organic treatment was tried. It proved to be the answer to the problem. In nearly three years of operations, there has not been a single shutdown of this plant due to water problems.

In the treatment of boiler water here, the problems requiring considerations were:

1) Maximum allowable concentration.
2) Freedom from scale formation.
3) Freedom from embrittlement.
4) Freedom from corrosion.
5) Economy of operating cost.

A concentration of silica much above 200 ppm in a boiler creates a danger of silicate scale formation, much the same as it does in a cooling tower. High alkalinities are dangerous in a boiler because of the possibility of embrittlement.

The maximum allowable concentration ratio in the boilers at this point, is governed, first, by the silica concentration, and, second, by the maximum allowable alkalinity. Here it was found that their raw water could be concentrated only about three times before the alkalinity in the boilers would reach a limit above which the boilers would be damaged. This limitation existed even in the presence of the treatment currently being used, despite the fact it contains the best available embrittlement inhibitors.

The problem of scale formation here was solved by the use of a phosphate-organic type boiler treatment. The phosphate reacts with the hardness in the water to form a sludge, which is prevented from adhering to the boiler tubes by the presence of the organic material in the boiler water treatment.

Embrittlement is controlled by the presence in the treatment of both inorganic and organic materials designed to prevent damaging concentrations of caustic forming in crevices where embrittlement is usually most severe.

Now, the problem of corrosion in water as alkaline as that at this plant, is usually not a factor when the feed water is maintained in an oxygen-free condition. And the boiler feed water preparation at this plant is so good that little oxygen is found in their feed water.

Constant Vigilance Necessary

After a chemical treatment was developed that economically converted the water problem from a major trouble to a minor one, experience indicated that something else was needed. That missing ingredient was constant and expert control of the ever-changing conditions in the water system.

First, this plant's management realized that their water problem, with or without treatment, was sufficiently important to justify the expenditure of time and care on the part of their operators and technical staff. Accordingly, water analyses which had not run on a fixed schedule were started on a regular basis on both the cooling system and the boilers.

After some study, it was decided that while analyses run every other day were sufficient to control the boilers, daily analyses were required on the cooling towers. These regular analyses are immediately recorded as they are made on a log sheet. This log is first reviewed by the technical staff of the plant, and then a copy is forwarded to the office of an outside consultant.

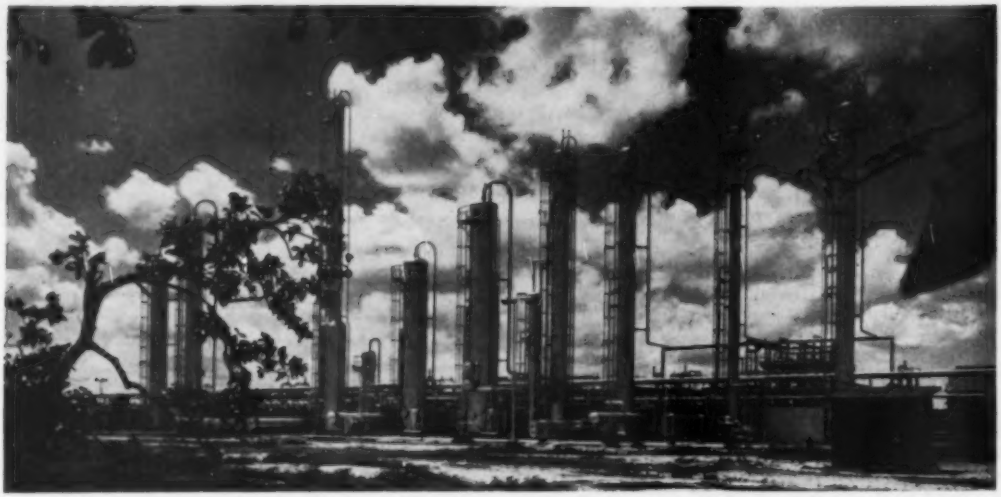
Thus, immediate control is continuously effected by this plant's operating and technical staff at the plant, as well as by the highly specialized service of the water treatment engineers who examine and analyze the records made of the day-to-day operation.

Moreover, periodic water samples are submitted to an outside laboratory, as assurance that the tests run daily by the plant personnel are not affected by changes in the strength of reagents or by analytical procedures that might be improperly handed on from one operator to another. In addition, an engineer, especially trained in water chemistry and with actual experience in the operation of industrial water systems, calls at the plant every three to six weeks for a conference with the technical staff.

The successful solution of Plymouth's water problems is based on three equally important foundations. First, the proper chemicals were discovered by the careful evaluation of a number of available chemicals under actual operating conditions. Second, it is realized at this plant that precise control of the chemical dosage is as important as choosing the proper treatment. Third, specialized technical assistance is employed to check on daily operation and provide an independent check on the analytical procedures. In this manner, Plymouth is assured that sound data, properly interpreted, are used for continuous control of the system. This program has paid off in increased heat transfer efficiency and lower maintenance cost.

ACKNOWLEDGMENT

The assistance of W. L. Parker, petroleum engineer in charge of Plymouth's Sinton operation, C. S. Hilton, superintendent, and Arlan Maley, chemist in supplying data used in this article, is gratefully acknowledged.



Plant start up and shut down have been reduced to a push-button proposition in Taylor Refining Company's cycling plant at McAllen, Texas.

Taylor-Mayfair Cycling Plant Features New Instrumentation

J. J. MAURER, JR.
Taylor Refining Company
and
W. T. HENRICHSON
Gasoline Plant Construction Corporation, Corpus Christi

WHILE THE fundamental processes employed in recovering liquefiable hydrocarbons—absorption, stripping and fractionation — are common to all gas cycling plants, many variations in processing units exist from installation to installation dictated by conditions under which each plant is expected to operate. Although the control of cycling plant processes is usually simple and straightforward, improved variations in control techniques are constantly being utilized in order to provide maximum efficient operation and plant safety, with a minimum of process supervision. Characteristic of the latest developments in instrument design is the new cycling plant at McAllen, Texas.

MANY control innovations have been applied with a resulting increase in operating efficiency at Taylor Refining Company and Mayfair Mineral Incorporated's gas cycling plant, recently constructed in McAllen, Texas.

Rich Oil Heater Control

Typifying these departures that have been made from conventional straight-run instrumentation is the rich oil heater control system, illustrated schematically. In this system, plant startup and shutdown have been reduced to a push-button proposition. Positive control of effluent rich oil temperature is obtained, with elimination of hazards attendant to heater operation.

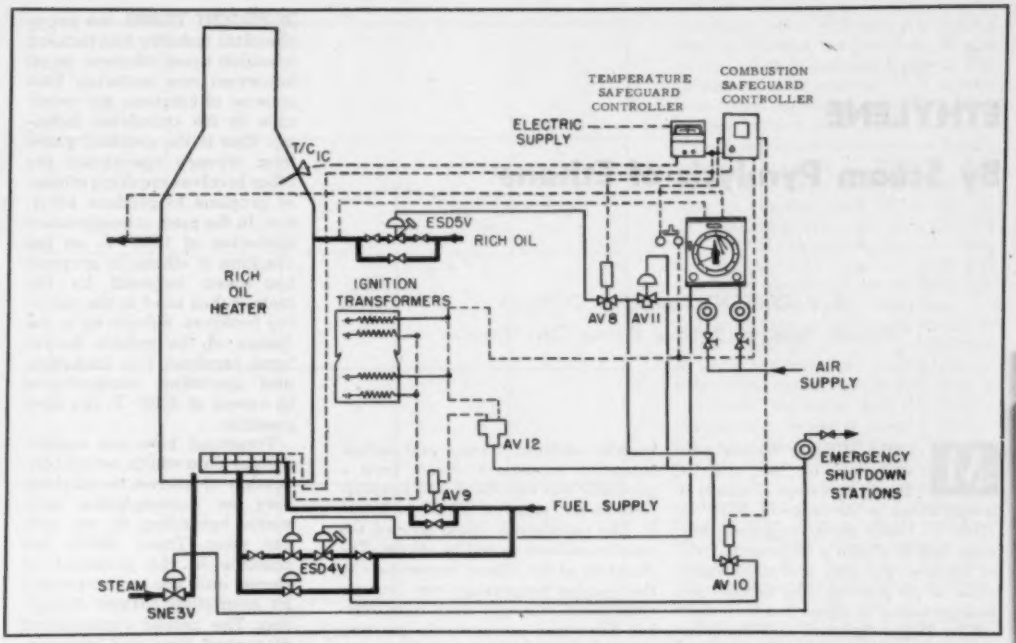
In operation, heater shutdown occurs in the event that stack temperatures exceed a specified maximum limit. Similarly, startup can only be effected when the stock temperature is below the maximum temperature set point.

On startup, when the stack temperature is below the limit, a relay coil in a temperature safeguard controller is energized, resulting in closing of the relay contacts. This opens an air pilot valve *(AV-8)* which controls flow of air to the diaphragm of rich oil emergency shutdown valve *ESD-5V*. Opening of this valve permits oil to flow to the heater.

The operator next presses the start button, resulting in 1) opening of air pilot valve *AV-9*, thus permitting fuel gas to flow to the pilot burner, 2) energizing of ignition transformers that ignite pilot burner gas, and 3) energizing of the combustion safeguard controller transformer, which in turn energizes a relay coil by closing a current through a safety switch.

Combustion Safeguard

In the event that any abnormal operating condition prevents ignition of the burner gas, the relay coil and safety switch in the combustion safeguard controller interrupt flow of fuel gas to the heater. This action is made possible by tying in the functioning of the safety switch with time delay establishing the pilot flame. The pilot flame is part of the combustion safeguard controller's electronic circuit. When no flame is present, rectification



Rich Oil Heater Control System at Taylor Refining Company and Mayfair Mineral Incorporated's Gas Cycling Plant, McAllen, Texas

of the electric current will not occur. After a specified interval of time, the safety switch operates to de-energize the system. The switch must then be reset manually and the startup procedure repeated.

On the other hand, if ignition is effected when the startup button is pressed, the pilot flame completes the circuit and a second relay is energized. This results in 1) shunting of the safety switch, 2) de-energizing of the ignition transformers and the red pilot light in the controller, and 3) energizing of valve *AV-10*, thus permitting emergency fuel shut-off valve *ESD-4V* to be manually opened and latched in position. After *ESD-4V* has been opened, a temperature controller on rich oil effluent is reset, to maintain the desired temperature, by controlling the fuel gas to the heater.

System Shutdown

Heater shutdown is accomplished by either depressing a "stop" button or by manually operating heater shutdown valves located at any one of four emergency shutdown stations.

When the former method is chosen, valves *AV-9* and *AV-10* close and interrupt flow of fuel gas to the heater and pilot flames. Circulation of rich oil through the heater continues. Interruption of all gas and oil flows can be effected by lowering the control index of the temperature safeguard controller to a level below the furnace temperature set point. This action closes valves *AV-8*, *AV-9* and *AV-10*, causing complete shutdown of the heater.

The alternative for accomplishing shutdown is by manual operation of any one of the heater shutdown valves. This action closes valve *AV-11* which in turn results in closing of the emergency fuel shutoff valve, *ESD-4V*, and the rich oil emergency shutoff valve, *ESD-5V*. Simultaneously, a pressure operated switch *(AV-12)* is actuated, energizing valve *AV-9* so as to interrupt the flow of gas to the pilot flame. Steam snuffing valve *(SNF-3V)* is also opened and discharges steam into the heater fire box.

General Instrumentation

In addition to the rich oil heater control system described above, extensive instrumentation is employed throughout the plant in order to control critical process variables. Since these instruments are operating equipment, a great deal of consideration was given to how and where they would be located in order to achieve maximum effectiveness.

In view of the prevailing mild climatic conditions, it was felt that the added expense of a centralized control room was not justified. Local mounting was also ruled out, because of inherent disadvantages. These include the expense of weatherproofing individual instruments, and the inconvenience resulting from the fact that operators are compelled to walk at varying lengths around and between processing equipment in the performance of duties, such as reading and changing charts.

A compromise arrangement of locally grouped instrumentation was finally selected, thus providing many of the advantages of both local and centralized instrumentation. The instruments for each group of processing equipment are located on a small panelboard (with integral overhanging shelter) convenient to the equipment being controlled. The advantages of this arrangement include: 1) decrease in cost of instrumentation due to short instrument leads, 2) operator convenience resulting from proximity of grouped instruments to equipment under control, and 3) economy in protecting instruments and operators from the elements.

ETHYLENE

By Steam Pyrolysis of Ethane

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IN RECENT YEARS, the petrochemical industry has focused attention upon ethylene as an important raw material. Two sources of ethylene are available to the petroleum industry. One is the cracked gases from refinery operations; the other involves cracking ethane or propane to produce ethylene. In the past, a temperature limitation of 1500° F. on the cracking of ethane or propane has been imposed by the metal tubes used in the cracking furnaces. Advances in the design of the pebble heater have removed this limitation, and operating temperatures in excess of 2000° F. are now possible.

Presented here are experimental data which reveal conversion of ethane to ethylene may be accomplished with yields exceeding 60 per cent per pass. These yields are possible in the presence of steam and are accompanied by negligible carbon deposition. The proper combination of contact time and temperature must be made to avoid undesirable side reactions which decompose part of the ethane and ethylene.

McCULLOUGH & Walton[4] present data on the catalytic dehydrogenation of ethane at temperatures in the range of 1050° to 1200° F. Under these conditions they were able to obtain a 20 percent yield of ethylene per pass and an ultimate yield of 80 percent. The thermal dehydrogenation of ethane has been studied by Hepp, Spessard and Randall,[3] Eastwood and Potas,[2] and Tropsch and Egloff.[5] The early work of Cryder and Porter[1] showed that the pyrolysis of ethane in the presence of steam gave substantial formation of carbon monoxide. Their contact times, however, were too long to prevent the water gas reaction from taking place. The present investigation was carried out with contact times low enough so that the water gas reaction was greatly suppressed. The data obtained indicate that by proper control of temperature and contact time, good conversion of ethane to ethylene can be accomplished without use of a catalyst. Conversions in the range of 60 percent per pass were obtained without difficulty.

Previous investigations have resulted in the publication of a small amount of data at high temperatures. The present investigation differs from previous work in that steam was employed at high temperatures to serve as a heat transfer medium, diluent and carbon formation suppressor. Steam from a generator was superheated to temperatures in the range of 1700° to 1900° F. The superheated steam entered the reactor and was joined by ethane. The elevation of the ethane temperature to the reaction temperature was thus accomplished in a very short time interval. The steam prevented the gas temperature from falling appreciably during the heat consuming cracking reaction. The reactor tube consisted of a tube of non-porous alundum 0.189 inches in diameter and 4 inches in length. A thermocouple was so arranged that actual gas temperatures in the reaction chamber were measured. Carbon deposition in the reaction chamber was negligible.

Contact Time

It is necessary to obtain a correct combination of temperature and contact time to provide maximum conversion without sacrificing ultimate yield. It was found possible to carry out the reaction at high temperatures and very short contact times so that the dehydrogenation reaction was the only one taking place to any appreciable extent. Under these conditions the side reactions of hydrocarbon and steam were held to a minimum. Table 1 presents experimental data for several sets of conditions. Steam was present in all runs in the ratio of about four to six volumes of steam to one volume of ethane. The calculated molecular weight was determined on the basis that the products included only ethylene, hydrogen and unreacted ethane. A large difference between the measured and calculated molecular weights thus indicates an increase in the amount of extraneous decomposition of ethane and ethylene.

For comparison purposes, Table 2 presents data calculated from information published by other investigators. Steam was not present in these runs.

TABLE 1
Steam Pyrolysis

Run Number	13	14	7	28	9
Temperature, °F.	1550	1600	1700	1800	1890
Contact Time, sec.	0.0143	0.0134	0.0143	0.0141	0.0135
Yield of Ethylene, Mol. percent	11.0	24.1	60.3	71.5	64.1
Analysis of Product Gas:					
Ethylene, Mol. percent	10.0	19.5	35.2	36.0	31.4
Carbon Monoxide, Mol. percent	1.1	1.1	2.6	4.0	6.1
Measured Mol. Weight	27.2	24.3	17.5	15.1	14.7
Calculated Mol. Weight	27.0	24.2	18.7	17.5	18.3
Volume Expansion	1.10	1.23	1.71	1.99	2.04
Steam to Ethane Ratio	5.4	5.9	4.2	4.3	4.4

TABLE 2
Ethane Pyrolysis Without Steam

Investigator	Eastwood & Potas[2]		Hepp et al.[3]		Tropsch and Egloff[5]
Temperature, °F.	1525	1770	1785	1902	2012
Contact Time, Sec.	2.3	0.12	0.013	0.008	0.0105
Yield of Ethylene, Mol. Percent	52.9	60.3	60.4	67.9	60.6
Ethylene in Product Gas, Mol. Percent	24.7	28.6	36.6	36.1	27.4
Mol. Weight from Analysis	14.0	14.2	18.2	16.0	...
Calculated Mol. Weight	19.6	17.3	18.7	17.9	18.7
Volume Expansion	2.13	2.11	1.65	1.88	2.21

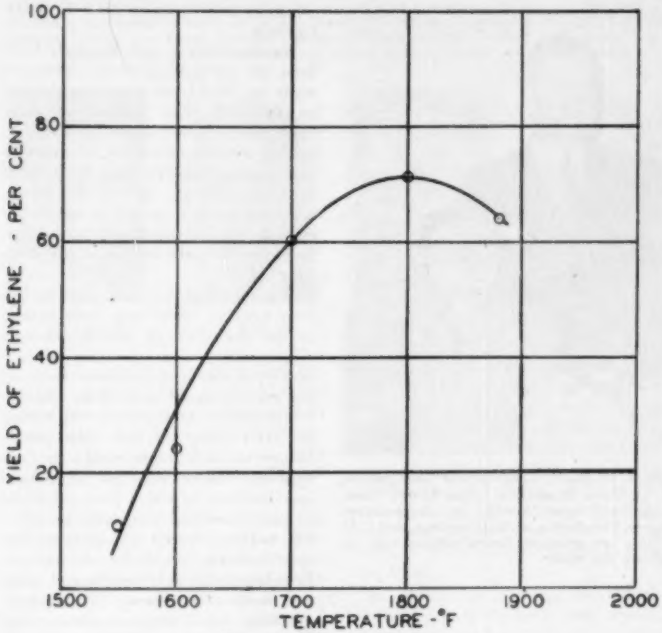

Figure 1. Yield vs. Temperature.

The data of Eastwood and Potas[2] indicate that their contact times were too long to avoid undesirable side reactions. Their contact time of 0.12 seconds at 1770° F. is eight times longer than Run No. 28, of Table 1, which was carried out at a temperature of 1800° F. Although the contact time of Run No. 28 was much shorter, the conversion to ethylene was 18 percent higher. If the contact time is either too short or too long, optimum yields of ethylene will not be obtained. Run No. 13, at a temperature of 1550° F., shows 11 percent conversion. Obviously the contact time at this temperature was too short to permit the maximum yield of ethylene. The higher the temperature the shorter the contact time required for maximum ultimate yield.

Temperature

Runs 7, 9, 13, 14, and 28, all with a contact time of approximately 0.014 seconds, show different conversions due to different temperatures. A plot of these data is given in Figure 1. The maximum conversion of 71.5 percent was found to occur at 1800° F. A shorter contact time would probably show a maximum conversion at a temperature in excess of 1800° F. Run No. 9, at a temperature of 1880° F., gave an ethylene yield of 64 percent. In comparing this with Run No. 28 at 1800° F., it appears that the contact time in No. 9 was too long and maximum conversion to ethylene has been prevented by side reactions.

The amount of carbon monoxide in Runs 9 and 28 indicate a difference in amount of water gas reaction taking place. The contact time in both runs is essentially the same but the higher temperature results in greater formation of carbon monoxide. This increased side reaction is also indicated by a wider discrepancy between the measured and calculated molecular weights. The data of Eastwood and Potas[2] at 1770° F. show a lower molecular weight than data from Run No. 28. This denotes less splitting of ethane molecules in Run No. 28.

Comparison of Table 1 with Table 2 indicates the feasibility of operating a selective dehydrogenation reaction in the presence of steam. Additional work is under way to investigate the most effective combination of temperature and contact time with regard to maximum selectivity.

REFERENCES

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[4] McCullough and Walton, Ind Eng Chem, **41**, 1455 (1949).
[5] Tropsch and Egloff, Ind Eng Chem, **27**, 1063 (1935).

Distillate Fuels Stability Research

Results of the first year of an extended program by the Bureau of Mines and the Western Petroleum Refiners Association seems to indicate that more basic research is in the offering to establish the causes behind the instability and incompatibility of distillate fuels. The program has as its main objective the determination of the cause or causes of the phenomena that result in accumulation of sludge and gums upon storage of distillate fuels and also of the deposition of sludge or gums upon the mixing of fuels of different types or from different sources.

When the two-phase research program got underway approximately one year ago, the initial approach was a very comprehensive storage program which included all types of fuels under a number of different conditions. An exhaustive series of tests, both empirical and of a basic chemical nature, were made on the fuels as received and which will also be made on the fuels after storage. Correlation of the storage behavior with the various tests should furnish clues as to some of the reactions that may be causing deposition of the sludges and gums.

Approximately 35 samples of distillate fuels from the Western Hemisphere and the Middle East are under study. All samples undergoing storage tests are being stored in quintuplicate in glass bottles under seven different conditions of storage in a hot room at 110° F. with a cycling operation that permits a short period each day at 90° F. for breathing of the samples. Crossblends have also been made and are under the same storage conditions, so that approximately 3000 samples will be under storage at various times. Extensive tests are being made on the original samples and these tests will be repeated at the end of the storage period of approximately one year. Interim tests on samples removed from storage are also being conducted at suitable intervals.

NGAA Officers, 1951-1952—Front row, left to right: R. W. Heath, Signal Oil and Gas Company, Long Beach, Calif., vice president; John F. Lynch, La Gloria Corporation, Corpus Christi, Texas, president; and Z. C. Ambrose, Southwest Gas Producing Company, Monroe, La., vice president. Standing, left to right: James E. Pew, Sun Oil Company, Philadelphia, retiring president, and F. M. Perry, Cities Service Oil Company, Bartlesville, Okla., vice president. Several officers were not present when this picture was made.

NGAA Has Record Sparked With Real Service to Industry

AN ORGANIZATION "conceived of necessity and born in adversity," the NGAA since its first days has rendered invaluable service to its segment of the oil industry. It has grown from a group of less than 100 to more than 1300, which attended its 1951 annual meeting, but more important than these numbers are contributions resulting from research which it has sponsored. Industry standards, now generally accepted, are but one of these.

The 1952 annual meeting is scheduled April 30-May 2 in Houston.

THE history of the Natural Gasoline Association of America, which is, in truth, the history of a nation's vast and successful natural gasoline development, offers thrilling reading not only for the newcomer to the oil industry but also for old timers who invariably get a lift every time they review its progress and growth.

"Conceived of necessity and born in adversity" applies to this group in every sense. Chaos reigned supreme when the first organization was set up more than 30 years ago, a chaos which caused the first president to repeat the widespread "doubt that we can maintain an association."

As prescribed by the same man, M. W. Welch, then general manager of Tidal Refining Company, a willingness to cooperate in problems peculiar to this segment of the oil industry, seemed to consummate the organization miracle. Actually this cooperation has turned into the keystone of a thriving organization and is certainly characteristic of the natural gasoline industry itself. Not all problems have been solved—nor will they ever be in such a rapidly changing industry—but NGAA's own history stands as a pattern, and an efficient one, whereby solutions are sought and usually reached.

Standardization and research have been the outstanding contributions made by NGAA since its organization on April 22, 1921. Work along these lines has been continuous and the resulting contributions to a smoother functioning industry have in the past been tremendous. As for the future, the association's record is assurance enough that outstanding services performed will spark its record for years to come.

When the organization first set up housekeeping, there was little system in the operation of plants, business relationships were a maze of disorderly procedure, and there were being manufactured more than 100 different grades of products, all having the same name but with little resemblance to each other except in their wildness. There were no standard specifications by which products might be purchased and there were no scientific testing methods by which product specifications could be determined. Regulations for safe handling of products were non-existent. "Casinghead" gasoline was a drug on the market. These were the conditions when the NGAA pioneers came together in Tulsa. The only certainty was that a bad, bad situation existed.

Be it said to their credit, the charter group began with the internal problems of the industry rather than attack, as men with less foresight might have done, the market and sales end of their problems. They realized that setting their own house in order was the prime consideration, that if this could be done, many of their external puzzles would become less difficult.

Considerable stigma had become attached to the name "casinghead gasoline" so early in the game "natural gasoline" was adopted officially and at the first opportunity the group changed its name from the "Association of Casinghead Gasoline Manufacturers" to the "Natural Gasoline Association of America." The aims and purposes of the organization as gleaned from early proceedings might be outlined as follows:

1) To establish natural gasoline as an acceptable blending material for motor fuels.

2) To develop technical standards for testing products so that standard specifications for each product could be established.

3) To work with the U. S. Bureau of Mines in establishing safety standards for handling and transporting products.

LONG PROMINENT IN NGAA—LaFortune, executive vice president of Warren Petroleum Corporation, served as NGAA president, 1937-39; Buchanan, now president Hiwan Oil & Gas Company, served as NGAA head 1923-25; Bunn, NGAA president 1939-41, is with Phillips Petroleum Company; Miller, who served as NGAA secretary 1928-34 and as president 1941-43 now is with E. I. du Pont de Nemours & Company; Lynch, president of La Gloria Corporation, was elected NGAA president last year; Lowe has been NGAA secretary-treasurer since 1934.

J. A. LaFortune

D. E. Buchanan

George P. Bunn

Ray E. Miller

John F. Lynch

William F. Lowe

4) To work with the Bureau of Explosives and the ICC in establishing better regulations and more equitable freight rates in tank car transportation.

5) To increase the efficiency and reduce the cost of plant and field operations.

Many of these objectives have been attained, as anyone familiar with present conditions will quickly recognize. All accomplishments, needless to say, are the cumulative result of careful planning, aggressive action and keeping everlastingly at it. New problems arise as external conditions change and as developments appear within the industry itself. This has called for continuous vigilance, on the part of the association's staff and officers and to this alertness must be —and has been—added energetic activity by association committeemen and other members.

For example, the baby wasn't dry behind the ears before the technical committees of the association had reduced the number of products from more than 100 to a total of 10. And for each of these—six blending grades and four motor gasoline grades—there were definite written specifications on gravity, initial boiling point, end point, color, vapor tension and recovery. Tentative tests methods for these qualities had also been created.

And so it has gone along through the years. Cooperative effort and financial aid have been available not only in winning lawsuits involving patents that benefited the entire industry, but also in the association's program for improvement and standardization of product.

Research of course, has deserved and received much attention from NGAA. It would take more space than is available here to list resulting benefits from this research program which has been almost continuous since it was started in 1926. Eminent scientists have been retained on an annual basis to work on specific problems, such as 1) develop, substantiate and dramatize the valuable characteristics of natural gasoline, this by increasing motor fuel volatility to improve starting and warmup characteristics; and 2) discover better use of products from gasoline plants in aviation fuels.

In addition to these specific laboratory projects there have been several cooperative road tests held in conjunction with other national organizations. The first of these was in 1932 and the latest series in 1947. Results and data on all these tests were widely distributed by the association in book form.

The Reid Vapor Pressure method actually originated with the association which, in 1924, offered a prize for the best way of determining "vapor tension" or the degree of wildness of a product. Reid's original idea, as subsequently improved and developed, was adopted by the association as a standard in 1928. Two years later it was recognized as standard by the American Society for Testing Materials. It has been perfected into one of the most valuable specification tools used in the refining branch of the oil industry.

Perfection of the gravity balance, an instrument used to determine the specific gravity of natural gases, is another industry tool of immense value in which NGAA played a major development role.

The association also standardized certain forms such as the casing head gas purchase contract that had much to do with bringing stability to the industry. Another standard was the method of testing natural gases to determine their natural gasoline content, a work that was done in cooperation with the American Gas Association. As in the case of specifications for products, which have been revised a half dozen times since the first set was adopted in 1921, this AGA-NGAA Code 101, adopted in 1924, was revised in 1927, 1933 and 1943.

Other technical standards developed by NGAA committees include: test methods and specifications for LPG, originally adopted in 1931 with latest revision in 1951; standard factors for volume correction and specific gravity conversion of LPG, adopted in 1942; table of physical constants for the paraffin hydrocarbons, adopted in 1945 as a joint standard with the California Natural Gasoline Association; method of calculation of high-pressure gas measurement, adopted in 1942, and low temperature fractional analysis procedure, adopted in 1946.

More problems for research and study resulted from the 1941 merger with NGAA of the American Recycling Association whose members immediately sought a solution to the problem of obtaining a representative sample for analysis purposes of high-pressure two-phase gas streams. A highly useful method was developed following full-scale tests by recognized scientists retained for the task. A project now in its ninth year of operation is studying the destructive corrosion found in high-pressure gas-condensate wells.

More and more attention has been paid in recent years to LPG problems, the technical committee having given several years study toward improving the accuracy of test methods for these products.

Currently NGAA technical committees are engaged in studies involving the various tests controlling operations at plants, on which a manual is being prepared; a study of factors in high pressure absorption; the odoriza-

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Mutuality of Interests Fostered by California Natural Gasoline Group

ITS PURPOSE of fostering cooperation industry has been achieved through thousands of man hours since the organization 26 years ago of the California Natural Gasoline Association.

In its effort to serve as a medium for the solution of questions common to opearting companies, the association has and does recognize the mutuality of interests and problems within the industry.

Take CNGA's technical bulletins some of which have required more than three years to write. At present there are available to the industry 17 of them covering virtually every phase of testing, measuring and sampling of natural gas and natural gasoline.

Purpose of Bulletins

Issuance of these bulletins are indicative of the association's belief that it cannot prosper if it works and lives within itself. The mutuality of interest carries with it an obligation upon each member to cooperate with the other in such a way as to reflect credit upon the entire industry.

Because of this type of thinking CNGA enjoys seats on the committees of API. ASTM and NGAA. "We acknowledge the cooperation of these fine organizations in collaborating with us in some of our technical work," E. R. Millett, Jr., secretary-treasurer said.

Geo. C. McLaren

E. R. Millett, Jr.

Purposes of the CNGA, which feels "that the individual member is the one to whom the greatest benefits of the association accrue" may be generally summarized thus:

1) To provide a common meeting ground for discussion of problems peculiar to the natural gasoline industry and to cooperate in the solution of these problems. Monthly meetings, which include a question and answer period, are held as is a forum in connection with the annual fall meeting. Attendance is large.

2) To provide a medium of standardization of industry equipment, methods, procedures and practices. In its history CNGA has had 2200 men enrolled as members and at present there are more than 700. Seventeen committees are active, these groups comprising 22 percent of the entire membership.

3) To disseminate among the membership timely and dependable information relating to the industry which will be beneficial both to them individually and to their companies. Programs at the monthly meetings of the three chapters are so arranged that each phase of the industry finds at least one of the papers presented of special interest.

A new service, recently instituted, is offered by an education committee which reviews technical and general articles as they are published, the pertinent ones being synopsized and sent to the membership. This committee also keeps the membership informed as to educational features such as short courses, lectures, etc.

CNGA memberships are divided into three classes: a) Any individual engaged in the manufacture or extraction of natural gasoline and/or liquid hydrocarbons from natural gas, or employed in work directly relating to the manufacture of such products by any individual or company. b) Any individual engaged in other branches of the petroleum industries such as refining, transportation, marketing, accounting, LPG, handling or selling natural gas, or employed by any individual or corporation. c) Individuals engaged in the manufacture and/or sale of equipment used in natural gasoline, natural gas, LPG, or petroleum industry. In addition, individuals who do not fall into one of these classes may become an associate member.

Bulletins of the association were purchased last year by individuals or companies in 17 foreign countries and 48 states at a cost of more than $5000. In 1929 these sales aggregated only $400. These technical studies range in price from $2 to $3 for members and from $2.50 to $4 for non-members.

Among the more popular publications are those dealing with: 1) "Procedure for the Charcoal Test for the Determination of the Gasoline Content of Natural Gas"; 2) "Tentative Standard Procedure for the Measurement of Natural Gas with Orifice Meters"; 3) "Tentative Standard Procedure for the Determination of the Corrected

Past presidents of CNGA, standing: P. S. Magruder, General Petroleum Corporation, 1939-40; R. S. Tulin, Shell Oil Company, 1950-51; F. J. Colton, Tide Water Associated, 1947-48; R. D. Gibbs, Union Oil Company, 1936-37; M. L. Arnold, Richfield Oil Corporation, 1945-46; L. V. Cassaday, Lomita Gasoline Company, 1940-41; H. R. Linhoff, Richfield Oil Corporation, 1938-39; J. B. Taylor, Signal Oil & Gas Company, 1939-50; C. D. Gard, Union Oil Company, 1944-45; W. W. Robinson, Jr., The Texas Company, 1942-43; William A. Kirk, California Southern Oil Company, 1948-49. Sitting: T. L. Taggard, Standard Oil Company, 1935-36; H. L. Eggleston, Analyst, 1934-35; R. E. Beckley, 1929-30; R. W. Heath, Signal Oil & Gas Company, 1943-44; Paul Barton, First President, 1926-27; N. H. Mull, The Texas Company, 1933-34; M. W. Kibre, General Petroleum Corporation, 1946-47.

Hourly Gas Coefficient (C') Used in the Measurement of Natural Gas by Orifice Meter"; and 4) "Tentative Specifications and Tentative Standard Methods of Test for Liquefied Petroleum Gases."

As a gauge of their worth it might be cited that during the past fiscal year 21 of the 25 papers presented at CNGA were selected for publication in more than one periodical. "These magazines have varied editorial policies and in some instances specialize in news of a particular field of the industry, so we feel selection by them is quite complimentary to the quality of our papers," Millett said.

The 1951-52 president of CNGA is George C. McLaren, Standard Oil Company of California. Millet, who has been secretary-treasurer since 1947, is in charge of the headquarters, 510 West Sixth Street, Los Angeles.

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tion of LPG; engineering and economic studies of underground cavity storage of LPG; and a program to reduce the human errors in low temperature fractional analysis of liquid hydrocarbon mixtures. The latter is a cooperative project in which 68 oil company and commercial laboratories are participating. The traffic and safety committees are active in their respective fields. Another comprehensive series of road tests is being planned for the summer of 1952 to test the relative capacities of current model cars to operate satisfactorily on volatile fuels in summer temperatures.

At each annual meeting there is made "The Hanlon Award for Meritorious service to the Natural Gasoline industry." R. C. Alden, Phillips Petroleum Company received the first such award in 1937 whereas last year it went to Walter J. Podbielniak. NGAA officials comprise a group that makes this selection each year from nominations submitted by oil companies, institutions and organizations.

The association's growth parallels that of the industry itself. In 1921, when it was organized the total annual production of natural gasoline was 11¼ million barrels having a value at the plant of $69.5 million. In 1951 products had risen to 160 million barrels with a value approaching $1 billion. When NGAA was organized, the daily average production per plant was 1124 gallons while today, with less than half as many plants, the daily average production per plant approaches 35,000 gallons. There were 78 men registered at the first convention, whereas last year 1312 attended, and officials feel sure this attendance will be exceeded at 1952 (April 30-May 2) annual meeting in Houston.

Popular Regional Meetings

In addition to its annual conventions, the NGAA holds a number of regional meetings each year which are open forums for the discussion of operating and field problems by, and for, the operating men themselves. During the past year these meetings were held at Tyler, Amarillo and Odessa, Texas, with an average attendance of 400 men. The entire proceedings of all meetings are printed and circulated to the industry.

Currently, John F. Lynch, La Gloria Corporation, Corpus Christi, Texas is NGAA president. William F. Lowe has been secretary since 1934. Headquarters are maintained in the Kennedy Building, Tulsa.

Supply Men's Affiliate

A close affiliate of NGAA is the Natural Gasoline Supply Men's Association which in addition to other activities issues the Engineering Data Book for the Natural Gasoline Industry. Now in its sixth edition, this date book is a highly valued compilation that has a definite place in every natural gasoline engineer's library. Fifteen thousand copies were printed of the 1951 issue which comprised 160 pages and contained hundreds of charts and tables.

Originally planned for the exclusive use of the natural gasoline industry, these manuals have had wide acceptance in the refining industry and are used as texts in a number of engineering colleges and have international distribution. They are given away by NGSMA member companies and it is another reason why the NGAA looks on its affiliate organization as a real service group.

The NGSMA was organized in 1928 for the purpose of promoting closer relationship among supply men and the members of NGAA 2) promoting high ethical standards of business in general and better understanding among supply men and 3) provide organized entertainment for the NGAA at its annual conventions.

Each year since 1928 NGSMA has provided the only organized entertainment at NGAA conventions. This has served to restrict the haphazard and distracting individual company effort during these sessions and provides a single evening of diversion where all natural gasoline and supply men can meet together for relaxation and entertainment. The idea worked so well and was so thoroughly approved by the NGAA board that is has been expanded under rigid rules of procedure into a plan highly satisfactory to all concerned.

The NGAA president is always a member of the NGSMA board and the two organizations have a common secretary. For 1951-52 NGSMA's president is Dallas S. Deem, American Air Filter Company, Tulsa.

During recent years the NGSMA membership has grown somewhat like that of the NGAA and it now has 171 members. The original membership comprised 29 men.

And, be it said, the association's "Cooling Tower" sessions have shown a similar growth in popularity from year to year.

NGSMA Officers and Board Directors, 1951-52—Seated, left to right: William F. Lowe, secretary, Dallas S. Deem, American Air Filter Company, president 1951-1952; L. L. Dresser, Dresser Engineering Company, immediate past president. Standing, left to right: Boyd F. Koepke, Aluminum Company of America; J. Dvorocek, Black, Sivalls & Bryson, Inc.; W. H. Edwards, Superior Manufacturing Company; M. D. Gilbert, Pittsburgh Equitable Meter Company; M. W. Conn, Perco Division, Phillips Petroleum Company; M. E. Duncan, Johns-Manville Sales Corporation; first vice president, R. P. Walker, Brown Instrument Company; H. M. Anderson, Brown & Root, Inc.; M. A. Ellsworth, The Fluor Corporation, Ltd., second vice president; A. F. Canada, Jr., Pacific Pumps, Inc., and C. C. Clover, Westcott & Greis, treasurer. Several officers were not present when this picture was taken.

Volumetric Contractions in Blending of Hydrocarbons

E. J. REEVES

Magnolia Petroleum Company, Beaumont, Texas

IN THE BLENDING of hydrocarbon fractions it is usually assumed that the total volume for the blend is equal to the sum of the volumes for the individual components. However, experimental data shows that this assumption is not exactly correct, for blending is usually accompanied by a change in volume, more frequently a contraction.

In a new approach to the prediction of volume changes accompanying blending, Mr. Reeves correlates blending data for various hydrocarbon liquids, including ethane, propane, butane, heptane, decane, benzene, naphtha, kerosine, and crystal oil. Volumetric corrections are presented in both tabular and graphical form and range as high as 30 percent variation from ideality in some cases.

VOLUMETRIC changes that might occur when blending hydrocarbons are important to both petroleum refineries and natural gasoline plants since the economic values assigned to individual products might be affected. These blends are normally assumed to be "ideal solutions" in which the total volume is equivalent to the sum of the volumes of the components. However, data available in the literature indicate that a slight volumetric contraction or expansion may be encountered.

Several investigators[2,10,11] report non-ideal solutions at high temperatures and pressures, particularly in the region of the critical point; but information on volume changes are meager for the many industrial operations involving liquid blends or gas-liquid solutions at normal atmospheric temperature and pressure. Thiele and Kay[12] reported a contraction of 0.25 percent volume when blending light and heavy petroleum naphthas. Van Der Vet[14] found a decrease in total volume of 0.2 percent for blends of propane and butane.

Experimental determination of the volume change is difficult and large errors may be involved. The most satisfactory way for evaluating mixtures is through calculation of the partial specific volume of the components of the blend by the graphical methods outlined by Lewis and Randel[6] and Roozeboom.[8] The partial specific volume is determined using the specific volume-weight composition relation. The relation for propane-benzene system is shown in Figure 1 and may be used to illustrate the method of calculation. Slight curvature of the line between 0 percent and 100 percent weight propane indicates that volumes are not additive and that a contraction takes place. The intercepts at 0 percent and 100 percent weight propane of a tangent to the curve in Figure 1 are the partial specific volumes of benzene and propane, respectively, at a blend composition corresponding to the point of tangency.

Within the range of 0-15 percent weight propane the tangent will pass through or very near the point for specific volume of benzene and it may be assumed that the partial specific volume and the specific volume are the same. The volume change may be attributed, therefore, only to the contraction of propane.

Specific volume-weight composition data for the following systems were found in the literature and used to determine partial specific volumes at low pressures and approximately

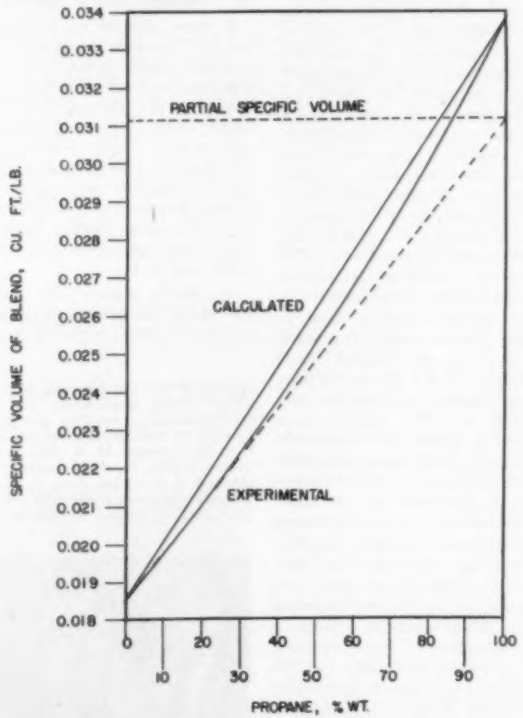

Figure 1. Specific Volume of Blends of Propane and Benzene. (Temperature 100° F.)

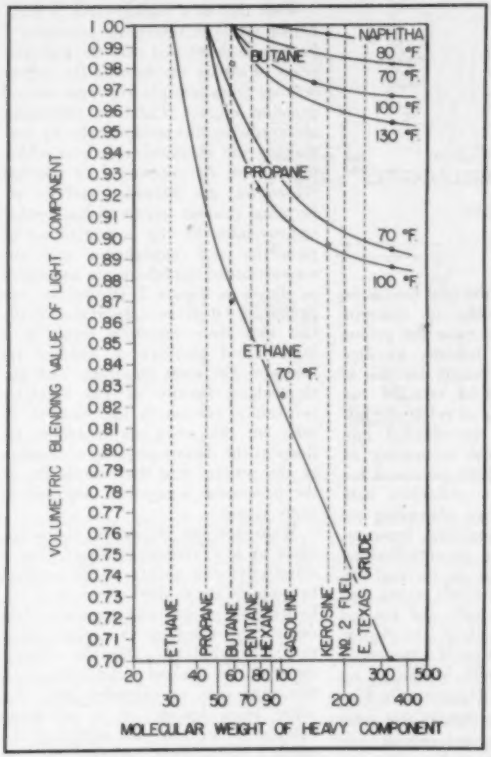

Figure 2. Volumetric Blending Value of Hydrocarbons.

normal atmospheric temperatures.

Ethane—Butane
Ethane—Heptane
Ethane—Crystal Oil
Propane—Butane
Propane—Benzene
Propane—Kerosine
Propane—Crystal Oil
Butane—Decane
Butane—Crystal Oil
Light Naphtha—Heavy Naphtha

In all of the systems investigated it was found that the volume change, within the range of 0-15 percent of the lighter component, might be attributed wholly to the contraction of the lighter hydrocarbon. From partial volume data a blending value for each component of the blend may be calculated. Blending value is defined as the ratio of the partial specific volume to the actual specific volume. By this procedure the blending value of the heavy component is 1.00 and the blending value of the lighter component depends on the temperature and the other hydrocarbon in the system. Blending values for the various hydrocarbon systems are shown in Table 1.

Only volumetric contractions were observed for the blends shown. At other conditions of temperature and pressure the change might be smaller or an expansion might even occur. However, the data shown in the table are for conditions most frequently encountered in industry and should be useful for economic calculations.

Blending values of lighter components as a function of molecular weight of the heavy component are shown in Figure 2. This chart permits estimation of blending values for hydrocarbon systems that might be important

TABLE 1
Blending Value of Hydrocarbons in Various Systems

HYDROCARBON SYSTEM				
Light Component	Heavy Component	Temp. °F.	Blending Value of Light Component	Literature Reference
Ethane	Butane	70	0.870	5
	Heptane	70	0.825	4
	Crystal Oil	70	0.700	10
Propane	Butane	60	0.982	14
	Benzene	100	0.923	2
	Kerosine	100	0.897	3
	Crystal Oil	70	0.894	9
	Crystal Oil	100	0.886	9
Butane	Decane	100	0.973	7
	Crystal Oil	70	0.982	11
	Crystal Oil	100	0.967	11
	Crystal Oil	130	0.954	11
Lt. Naphtha	Hvy. Naphtha	80	0.995	13

but have not yet been evaluated experimentally. Interpolation should be made only for saturated hydrocarbon blends or systems similar to those used in development of the relation. Unsaturated or other compounds might have entirely different volumetric properties. For example, propene and butene[1] show an expansion when mixed.

The method for use of the blending value chart shown in Figure 2 is outlined in the following problem: What is the blending value of propane in gasoline at 100° F.?

The molecular weight of gasoline is determined from API gravity and mean average boiling point. Intersection of the molecular weight line (which is 110) with the experimental line for propane at 100° F. gives the blending value of propane as 0.906, showing an apparent loss of 9.4 percent of the propane added. This blending value may be used for quantities of propane varying from 0 to 15 percent volume.

Conclusions

The investigation revealed that a change in volume takes places when blending saturated hydrocarbons at low pressures and normal atmospheric temperatures. This is contrary to the general belief that "ideal solutions" are obtained for such systems and that volumetric changes occur only at high pressures and temperatures. Within a small range, 0-15 percent volume of low molecular weight component, the contraction is a function of the molecular weights of the blend components.

ACKNOWLEDGMENT

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In REFORMING—
It's the Catalyst that Counts

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THE INCREASED octane requirements of today's motor cars have presented every refiner, large and small, with the immediate challenge of providing fuels for the present and future automobiles. The refining industry has made considerable progress in keeping pace with the increasing octane demand since the end of World War II by the installation of a large volume of catalytic cracking capacity. There is a definite limitation, however, in the ability of catalytic cracking to raise the octane level of the whole refinery gasoline pool. For the ultimate in improving the octane level of the overall motor pool it is necessary to resort to catalytic reforming. Herein described is the Atlantic catalytic reforming process, which is now emerging from pilot plant development to commercial operation.

THERE is a definite limitation in the ability of catalytic cracking to raise the octane level of the whole refinery gasoline pool. The principal reason for this is the high percentage of straight run and natural gasolines of relatively low octane which must be blended into motor fuels. Thermal reforming of these materials has been practiced for many years in some refineries with the express purpose of upgrading octanes. It is well recognized, however, that by virtue of the uncontrolled reactions taking place in thermal reforming, this method of octane improvement is both costly and limited in potential octane ceiling. The change in chemical composition of a thermally reformed naphtha with increasing reforming severity is illustrated in Figure 1. It will be seen that, in this case, octane improvement is realized primarily by the cracking of paraffins to olefins with a relatively minor change in the aromatic and naphthene content.

With this as a background, a number of catalytic reforming processes[1, 2] have been developed over the past few years to satisfy the demand for higher octanes from straight run and natural gasoline sources. Catalytic reforming accomplishes this economically by controlling the chemical reactions which take place. As contrasted to thermal reforming, the Atlantic catalytic reforming process accomplishes octane improvement by the isomerization of paraffins and naphthenes and the conversion of naphthenes to aromatics as shown in Figure 2. Olefins are not produced. Of prime importance is the fact that these reactions result in a high liquid recovery of finished reformate. The most important and distinguishing feature of any catalytic reforming process is the catalyst itself; for this, to a major extent, influences the daily operating economics of the process and the complexity of the processing equipment required to carry it out.

What are the important characteristics of a reforming catalyst? One is selectivity—the ability of the catalyst to promote the desired reactions of dehydrogenation and isomerization while controlling cracking. A second property is stability—will the catalyst maintain the desired yield-octane relationships over an extended life? Another must feature of a reforming catalyst is stamina—the ability of the catalyst to perform satisfactorily under the many varied conditions encountered in normal refinery operations.

To illustrate the role of the catalyst

This presentation was at the 40th Annual Meeting of the Western Petroleum Refiners Association in San Antonio, April 1, 1952.

Figure 1. Composition of Thermal Reformate East Texas Naphtha.

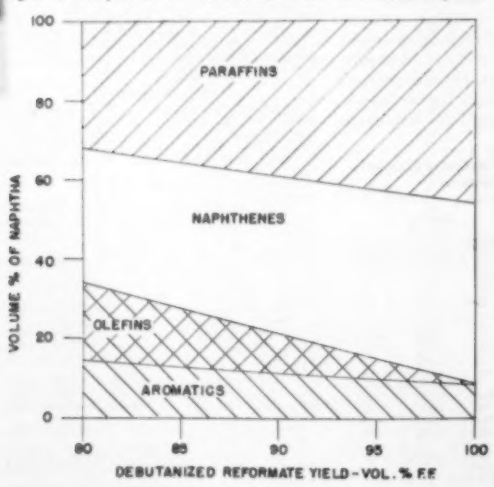
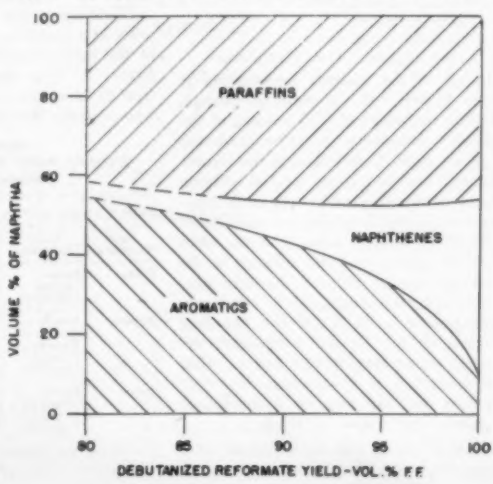


Figure 2. Composition of Catalytic Reformate East Texas Naphtha.



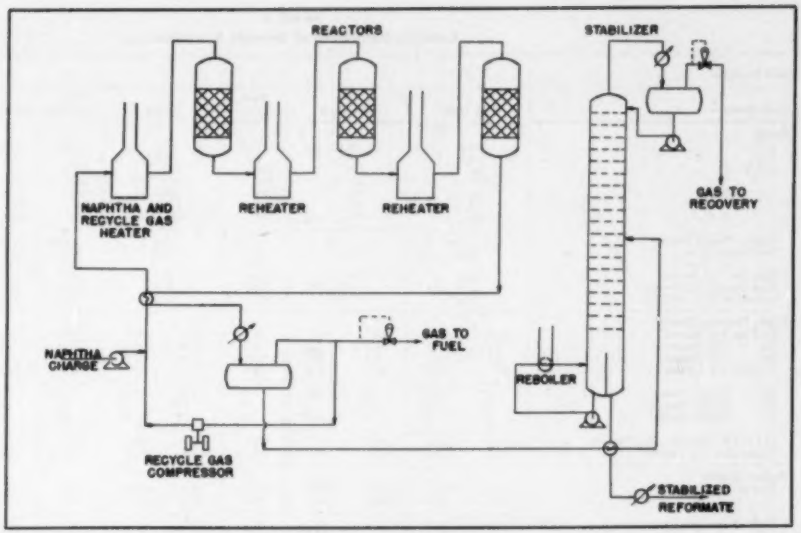


Figure 3. Simplified Flow Diagram — Atlantic Catalytic Reforming Process.

in obtaining the desired reforming results with minimum capital and operating expenditures we should like to describe the Atlantic catalytic reforming process. The Atlantic process is a continuous, normally non-regenerative process utilizing multiple fixed bed reactors. A schematic process flow diagram is shown in Figure 3. The feed naphtha, direct from tankage is joined with a recycle hydrogen stream. The mixture is heated to operating temperature by reactor effluent-feed exchange and a furnace before passing to the reactor section. Two or three reactors are utilized to accomplish the completed reaction at the desired temperature level. Since the catalytic reforming reaction is predominately endothermic, reheaters are employed between reactors to bring the naphtha-hydrogen mixture back to the operating temperature. The final reactor effluent, after exchange with feed, is cooled and passes to the gas separator. The recycle hydrogen stream is compressed and returned to the reactor while the net production is sent to fuel or other uses. Gas separator liquid is charged to a conventional fractionating tower for stabilization. Typical operating conditions for reforming an East Texas straight-run naphtha are shown in Table 1, while Table 2 lists utility requirements for a 10,000 barrel-per-day reforming operation.

The simplicity of the process is emphasized by the absence of any feed preparation facilities or costly catalyst regeneration equipment. In addition, the stabilized reformate is of such quality that no naphtha treatment is required before blending the product into finished gasoline. Under normal operating conditions, for motor fuel production, carbon laydown on the catalyst is negligible. If, however, regeneration of the catalyst should be required, this may be accomplished, in place, by passing a dilute air-in-steam mixture over the catalyst. When charging high sulfur stocks, it is desirable and practical to minimize the sulfur content of the reactor feed. In the Atlantic process, this is accomplished by a simple desulfurization of the recycle hydrogen stream (such as in a conventional amine unit).

Because of the simplicity of the equipment required for the process it is equally applicable to large or small units. Units are currently being constructed in sizes ranging from 750 to 12,000 barrel-per-day charge capacity. Investment costs range from $350 to $450 per barrel per day of naphtha charge.

TABLE 1
Atlantic Catalytic Reforming Process
Typical Operating Conditions
East Texas Straight Run Naphtha

Naphtha Feed: Boiling Range	175°—375° F.
Space Velocity: Lb./Hr. Naphtha Feed/Lb. Catalyst	3.0
Reactor Pressure, P.S.I.	500
Reactor Inlet Temperature	920° F.
Recycle: Mol Recycle Gas/Mol Naphtha Charge	10/1
Recycle Gas: Mol Percent Hydrogen	95%
Temperature Drop Across Reactors: 1st.	100° F.
2nd.	50° F.
3rd.	20° F.

TABLE 2
Atlantic Catalytic Reforming Process
Utility Requirements

Basis: East Texas Type Straight Run Naphtha	10,000 BPD Unit
Reactor Furnaces—Delivered Duty	57 Mm Btu./Hr.
Stabilizer Reboiler—400 lb. Steam	18,000 lb./Hr.
Recycle Gas Compression Requirement	1650 bhp
Power Requirements: Pumps, Fans, etc.	450 kw
Cooling Water Make-Up	175 gpm

Pilot Plant Development

The Atlantic catalytic reforming process is the result of several years of development work. Fowle et al.[3] have reviewed the development of this reforming catalyst. A six barrel-per-day continuous pilot plant has been in operation for nearly two years evaluating a wide variety of potential feed stocks and catalyst preparations. The basic flow diagram of this pilot plant is essentially similar to the commercial units currently being designed and constructed.

Catalyst Performance

Typical pilot plant results from a variety of feed stocks are shown on Tables 3 and 4. Analysis of these data will reveal the excellent yield-octane relationship, which can only be obtained by a selective catalyst which maximizes dehydrogenation of naphthenes and isomerization of paraffins and naphthenes while controlling the undesirable cracking reactions. This is emphasized by the yield and quality data in Table 3. It will be seen that the yields of methane plus ethane are consistently below one weight percent of feed and that the purity of the recycle hydrogen stream runs approximately 95 mol percent hydrogen. This, incidentally, suggests utility other than fuel for the hydrogen make gas. Further evidence of the selectivity of this process is shown by the high liquid recovery of propane and heavier which for the wide range of feed stocks and

TABLE 3

Catalytic Reforming of Straight Run Naphthas

Feed Stock No.	1	2	3	4	5	6	7	8	9
Crude Source	East Texas	East Texas	West Texas	Oklahoma	Mid-Continent	California	Tucupido	Gulf Coast	Gulf Coast
Charge									
API	56.5	54.6	51.6	51.5	47.9	46.9	50.2	50.2	53.1
RVP	0.8	0.3	0.1	0.5	0	0	0.8	0.2	0
ASTM 0	181	218	228	242	317	294	232	208	196
10	211	236	247	259	324	295	250	282	226
50	255	268	281	279	336	309	274	306	280
90	320	317	346	318	356	338	312	355	350
E. P.	370	365	406	348	401	360	374	396	382
Sulfur—Weight Percent	.005	.005	.092	.013	.002	.14	.003	.047	.002
Res. Octane 0 cc	54.9	51.5	51.2	56.9	36.0	60.2	60.3	46.5	47.4
3 cc			70.9		63.1	76.1		66.9	72.9
Paraffins, Vol. Percent	42.2	42.1	40.5	42.6	48.2	27.4	39.5	46.8	49.2
Naphthenes, Vol. Percent	47.6	46.7	38.7	36.5	36.1	59.6	32.5	36.4	34.0
Aromatics, Vol. Percent	9.2	11.3	20.8	20.9	15.7	13.0	28.0	16.8	16.8
Yields, Percent of Feed									
C_5 Plus, Vol. Percent	90.9	88.7	84.4	86.7	89.2	91.0	88.9	89.5	88.4	93.1	85.2	87.4
C_4 Vol. Percent	3.9	7.5	8.2	6.3	7.7	4.8	6.4	5.5	4.1	3.0	11.8	8.6
C_3 Vol. Percent	2.3	3.7	5.1	3.8	3.0	2.9	3.9	5.4	3.7	2.5	4.7	4.9
C_3 Plus, Vol. Percent	97.1	97.9	97.7	96.8	99.9	98.7	99.2	100.4	96.2	98.6	101.7	100.9
H_2 Weight Percent	1.57	1.78	1.90	1.91	1.20	1.18	1.31	1.11	1.57	1.14	1.07	1.34
C_1 Weight Percent	.17	.27	.17	.12	.31	.08	.16	.21	.27	.09	.13	.23
C_2 Weight Percent	.20	.37	.43	.30	.34	.19	.28	.45	.51	.14	.42	.52
10 Lb. RVP Naphtha, Vol. Percent	103.1	96.8	96.2	99.7	102.3	103.7	100.0	102.1	101.5	107.4	96.5	100.6
Excess C_4's, Vol. Percent	−8.3	−2.6	−3.6	−6.7	−5.4	−7.9	−4.7	−7.1	−7.4	−11.4	0.5	−4.6
Product Quality												
C_5 Plus-Res. Octane 0 cc	80.3	86.2	92.6	89.2	81.0	83.4	88.5	83.0	91.6	84.8	86.2	82.2
3 cc	93.0	97.1	98.9	97.3	92.9	94.4	98.1	94.1	99.6	94.6	96.3	94.4
10 Lb. Naph. Res. Octane 0 cc	82.0	87.2	92.9	89.7	82.8	84.8	89.2	84.5	92.0	86.2	87.2	83.8
3 cc	94.0	97.6	99.1	97.9	94.0	95.3	98.5	95.0	99.8	95.5	96.9	95.2
C_5 Plus Naphtha												
API	52.2	50.5	47.8	47.8	50.2	48.1	48.2	46.1	43.1	47.2	47.7	49.7
RVP	2.6	3.1	2.3	1.8	1.9	2.3	3.0	2.2	4.0	1.6	2.7	1.7
ASTM 0	162	134	126	132	114	120	112	114	114	137	122	128
10	192	179	187	201	203	221	198	197	237	230	191	184
50	244	240	258	261	265	278	278	322	314	270	282	252
90	319	324	323	329	342	324	332	368	357	313	341	338
E. P.	393	394	389	389	408	394	383	442	421	387	425	418
Sulfur, Weight Percent	.001	.001	.001	.001	.002	.001	.001	.001	.001	.001	.001	.001
Hydrogen Purity, Mol. Percent at 500 psi. 95° F.	95.8	94.7	96.4	98.0	92.2	97.0	95.5	93.0	94.9	96.5	95.5	95.2

reforming severities illustrated runs from 96.8 to 101.7 volume percent of fresh feed. This is particularly significant in many refinery locations where fuel gas is of little economic or material value.

While it is of great importance to have a catalyst which produces high yield-octane values when relatively new, the stability of the catalyst in maintaining these results is a major factor in determining the economics of the process. This important feature was studied in a recent five-month run in the pilot plant. A standard, wide cut, East Texas naphtha was charged to the unit at intervals over the length of the run. These test data are shown in Figure 4, in which it will be seen that there was no change in the yield-octane relationship over the entire period. Data from two of these test periods are listed in column 1 of Table 3, together with the properties of the feed stock used in this program. Evaluation of this batch of catalyst was discontinued while operation was still entirely satisfactory at a catalyst life of 30 barrels of feed per pound of catalyst.

The danger of generalizing on the yield-octane results from various feed stocks is emphasized by reference to Figure 5 and Table 3. Curve A is the data previously referred to for a wide cut but East Texas naphtha. The effect of width of boiling range is shown by comparison of Curves A and B where it will be seen that, although the narrow boiling stock (Column 2, Table 3) had a 3.4 lower octane, the debutanized reformate was three points higher at the same yield. Data from Tucupido, an aromatic Venezuelan naphtha, are illustrated in Curve C, showing the effect of chemical composition on final yield octane results.

TABLE 4

Catalytic Reforming of Natural Gasolines

Charge Material	North Texas	South Texas
Charge		
API	68.1	67.4
RVP	4.7	8.3
ASTM 0	136	114
10	158	140
50	201	194
90	293	282
E. P.	362	351
Sulfur—Weight Percent	.001	.003
Res. Octane 0 cc	49.7	64.4
3 cc		83.7
Paraffins—Vol. percent	77.6	62.4
Naphthenes—Vol. percent	14.0	30.3
Aromatics—Vol. percent	8.4	7.3
Yields, Percent of Feed		
C_5 plus, Vol. percent	87.5 79.0	81.2
C_4 Vol. percent	9.3 15.5	11.4
C_3 Vol. percent	4.6 9.0	8.3
C_3 plus, Vol. percent	101.4 103.5	100.9
H_2 Wt. percent	0.50 0.50	1.20
C_1 Wt. percent	0.15 0.60	0.34
C_2 Wt. percent	0.30 0.99	0.68
10 lb. RVP Naphtha, Vol. percent	93.7 82.6	83.5
Excess C_4's, Vol. percent	3.1 11.9	9.1
Product Quality		
C_5 plus Res. Oct. 0 cc	73.9 80.5	88.5
3 cc	90.3 93.7	98.4
10 lb. Naph. Res. Oct. 0 cc	73.2 81.9	83.5
C_5 plus Naphtha 3 cc	91.0 93.9	88.6
API	68.4 67.8	62.9
RVP	5.9 7.3	8.3
ASTM 0	115 113	116
10	136 122	125
50	178 160	170
90	264 285	300
E.P.	334 337	360
Sulfur, Wt. Percent	Nil Nil	.001

While it is of great importance to have a catalyst which produces high yield-octane values when relatively new, the stability of the catalyst in maintaining these results is a major factor in determining the economics of the process. This important feature was studied in a recent five-month run in the pilot plant. A standard, wide cut, East Texas naphtha was charged to the unit at intervals over the length of the run. These test data are shown in Figure 4, in which it will be seen that there was no change in the yield-octane relationship over the entire period. Data from two of these test periods are listed in column 1 of Table 3, together with the properties of the feed stock used in this program. Evaluation of this batch of catalyst was discontinued while operation was still entirely satisfactory at a catalyst life of 30 barrels of feed per pound of catalyst.

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It has been stated that under normal operating conditions for motor fuel production carbon deposition on the catalyst is negligible. Under very severe reforming conditions or in the case of a major unit upset, however, carbon may be formed on the catalyst, reducing its activity. With the present catalyst this condition may be corrected by a simple regeneration operation, in place, using a dilute air-in-steam mixture to burn off the carbon deposit. This is an important feature of the process since it eliminates the need for expensive regeneration facilities in the plant and greatly extends the useful life of the catalyst.

The fact that this catalyst can be regenerated by air and steam brings out another significant characteristic; namely, that water has no harmful effect on the catalyst. This is important both from the standpoint of catalyst regeneration and the fact that it is un-

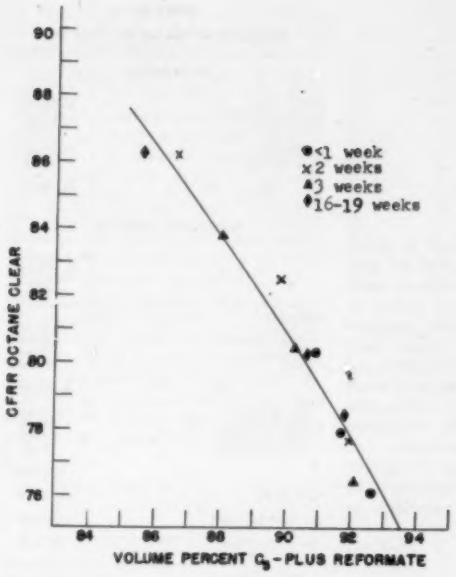

Figure 4 (above). Effect of Catalyst Age on Yield-Octane Relationships-East Texas Naphtha.

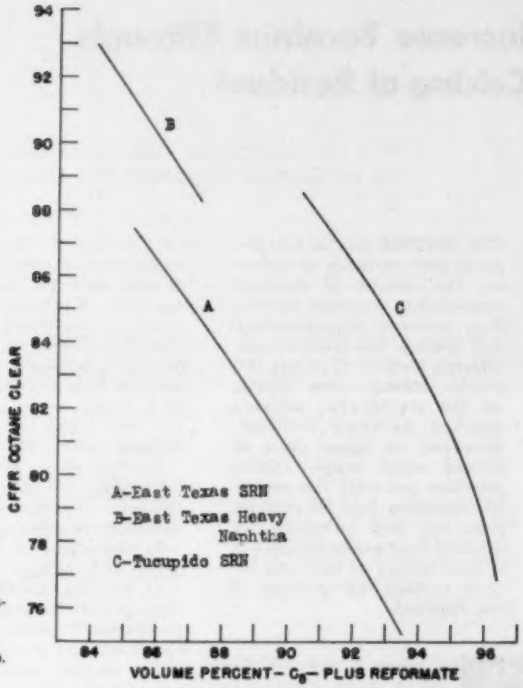

Figure 5 (right). Effect of Charge Stock on Yield-Octane Relationship.

necessary to provide facilities for elimination of water from the feed in normal refinery operations. During the above mentioned five month run an extended program of water injection into the reactor feed (in concentrations up to 1 weight percent) was studied. As would be expected from its chemical composition, no deactivation of the catalyst or change in product distribution was found.

It has been shown that essentially all the sulfur in the naphtha feed is converted to hydrogen sulfide upon initial contact with the catalyst and further that the various classes of sulfur compounds behave as hydrogen sulfide toward the catalyst. Sulfur is a temporary poison on the catalyst, using up some of the catalyst surface and reducing activity. The fact that this is a temporary phenomena has been repeatedly demonstrated by the catalyst returning to original activity when the sulfur level of the charge is reduced. At feed sulfur contents of about 0.1 per cent the depression of catalyst activity becomes significant enough to justify corrective action. Because of the large hydrogen recirculation, desulfurization of this recycle stream is a relatively simple method of handling higher sulfur feed stocks. For example, in an operation with no sulfur removal, charging a feed containing 0.10 weight percent sulfur, 40 pounds per hour of sulfur would be charged over one ton of catalyst at a given space velocity and hydrogen recycle rate. If the sulfur content of the recycle gas were reduced to 10 grains per 100 cubic feet the sulfur charged over the catalyst would be 9.5 pounds per ton of catalyst. This would be equivalent to charging a feed stock with 0.025 weight percent sulfur with no desulfurization facilities. The fact that the Atlantic catalyst is not susceptible to deactivation by water makes it possible to use a conventional desulfurization process on the recycle gas. The product gas from such a desulfurization operation is normally saturated with water. It has also been shown experimentally that although extreme concentrations of amines, such as might be carried over from a desulfurization unit in an upset, cause a decline in catalyst activity, this is also only a temporary effect. After reduction of the amine concentration to normal levels, the catalyst activity was immediately restored.

Experimental data have been obtained in which abnormally high concentrations of certain metals which might conceivably be found in naphtha feeds were charged over the catalyst. For example, arsenic in several volatile forms was included in the reactor feed in concentrations up to 10,000 parts per billion. No harmful effect, either temporary or permanent, was observed.

Eventually, after many months operation, physical and chemical changes in the catalyst will have reduced its activity to an undesirable extent. At this point, the catalyst will be returned to the supplier for chemical reconstitution.

Attempt has been made here to show the many factors which contribute to a successful catalytic reforming process. It is the writers opinion that catalytic reforming will play an important part in every refiner's program to remain competitive in gasoline quality. Basically, it is believed that the economic success of any catalytic reforming process will be determined primarily by the catalyst employed.

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* * *

Increase Earnings Through Coking of Residual

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THE REFINER has at his disposal four methods of reducing the volume of residual: visbreaking, vacuum distillation, solvent decarbonizing, and coking. The most advantageous method of course depends, among other things, on the particular refiner's market demand structure. However, in these days of limited crude supply coking provides not only the means for reducing fuel oil production, but also increases the yield of light products. Here is a case history of how one refiner tackled the problem of the residual.

THE refiner is continually seeking a more economical method for disposing of heavy crude bottoms. From topped crude the major products—residual fuel, asphalt, and coke—can be produced by one or more of the following processes:

PRODUCT	Major Processes
Fuel Oil Fuel Oil or Asphalt	Visbreaking Vacuum Distillation Propane Decarbonizing
Coke	Delayed Coking Continuous Contact Coking

Production of asphalt requires special crudes and as a rule that product is in limited demand. The more prevailing problem of disposal then becomes that of utilization either as fuel oil or as charge to a coking unit.

The economics of producing fuel oil versus coke has in the past been investigated innumerable times. The general conclusion reached is that in areas with a high fuel oil demand, production of coke has no economic advantage over the production of fuel oil. The increased value of the products resulting from coking as compared to fuel oil production are generally not large enough to justify the greater capital investment required for coking. In our own appraisal of methods for disposing of crude bottoms, we have viewed coking not so much as a method of reducing fuel oil production, although that often is quite important, but rather as a means of producing additional light products from a given quantity of crude. Since our major demand is for gasoline and distillate fuels, and our supply of crude oil is limited, we have chosen the coking route which provides maximum ultimate yields of light products.

To illustrate our method of appraising coking we have developed the economics of increasing gasoline production by two alternates:

1) Conversion of No. 6 Fuel via coking and cracking.

2) Refining additional crude via topping and cracking. For simplicity no increase in distillate fuel production is assumed in either alternate.

The specific cases considered are summarized in Table 1. The first column, the base case, represents the operations of a refinery processing 30,000 barrels per calendar day of 30° API mixed Arkansas crudes and selling reduced crude, amounting to 25 percent of the crude processed, as No. 6 fuel oil. The second column summarizes operations when processing the same quantity of crude but increasing gasoline production through the installation of coking and cracking facilities. The third column summarizes operations in which the same increase in gasoline yield is obtained by increasing crude processing. It will be noted that gasoline production increases 4,650 barrels per calendar day as a result of installing coking and cracking facilities. To achieve this increased production from crude would require an additional 7150 barrels per day of crude oil. Under the coking alternate, fuel oil is reduced 6700 barrels per day while it is increased 2150 barrels per day under the additional crude scheme.

TABLE 1

Basis for Evaluating Coking
(Quantities in Barrels Per Calendar Day)

Material Balance	Base	Additional Capacity	
		Delayed Coking	Added Crude
Crude	30,000	30,000	37,150
Gasoline			
Virgin	7,500	7,500	9,300
Cracked (Including Polymer)	7,000	9,950	9,850
Coker	.....	1,700	.....
Total	14,500	19,150	19,150
Distillates	6,000	6,000	6,000
Fuel Oil			
Reduced Crude	7,500	.....	9,300
Cracked	1,000	1,800	1,350
Total	8,500	1,800	10,650
Coke (Tons)	.....	(290)	.....
Fuel Gas (FOE)	1,200	2,300	1,650
Charge to Processing Units			
Topping	30,000	30,000	37,150
Catalytic Cracking	9,000	12,350	12,000
Thermal Cracking	4,000	5,950	5,500
Delayed Coking	.....	7,500	.....

TABLE 2

Appraisal of Coking Vs. Fuel Oil

INVESTMENT	
Delayed Coker	$2,300,000
Fluid Cracking Unit	1,500,000
Thermal Cracking	600,000
Sub-Total	4,300,000
Other Facilities	1,500,000
Total	$5,800,000

ECONOMICS APPRAISAL	Increase for Coking Dollars per Year
Realization*	
Gasoline	7,140,000
Cracked Fuel Oil	440,000
Fuel Gas	340,000
Coke	530,000
	$8,450,000
Costs	
Topped Crude	4,110,000
Delayed Coking	300,000
Catalytic Cracking	205,000
Thermal Cracking	180,000
	$4,895,000
Gross Profit	$3,555,000
Net Profit (52% Tax)	$1,900,000
Payout After Taxes	3.0 years

* Fuel Oil—$1.50 per barrel, Regular Gasoline—10 cents per gallon.

Table 2, based upon the estimated yields shown in Table 2, presents an economic appraisal of coking versus fuel oil production. An investment of $5.8 million is indicated for the expansion facilities on the assumption that cracking capacity sufficient for complete conversion of coker gas oil to gasoline will be provided. While in some instances the existence of excess facilities might reduce the total expenditure required, the investment does approximate that which could be allocated to the process. Using the current (Group 3) price structure, the net annual profit before depreciation but after allowance for federal income tax at the current rate of 52 percent is $1.9 million. At this price level the payout for the expansion facilities is 3.0 years. It will be noted in Table 2 that the profit for coking is essentially the difference between the value

This presentation was before the 40th Annual Meeting of the Western Petroleum Refiners Association in San Antonio, April 1.

of topped crude (fuel oil). Hence, payout is highly susceptible to the existing fuel oil price.

To illustrate the effect of price variation on payout, Figure 1 has been developed showing the payout for varying fuel oil price at constant gasoline price. Two curves are shown, one for a coke realization of $5 per ton and one for a coke realization of $10 per ton. Incidentally, this price range applies to fuel grade petroleum coke. In contrast, low sulfur coke suitable for metallurgical purposes is currently demanding up to $21 per ton. For example, if the fuel oil price increases from $1.50 per barrel to $2 per barrel, the payout increases from 3.0 to 4.6 years. At constant fuel oil doubling the price of coke, increasing from $5 to $10 per ton, reduces the payout less than half a year. Obviously then fluctuations in fuel price are more critical than fluctuations in coke price. As a rule coke prices are relatively stable varying mainly with the general price level. Fuel Oil prices, on the other hand, fluctuate substantially at a given level of the economy. Such fluctuations can be explained qualitatively as the combination of supply and demand coupled with the necessity of storing fuel oil in tanks. Because of limited storage facilities fuel oil price is utilized to equalize supply and demand. So long as land is available, such a factor is not overly critical in the establishment of coke price.

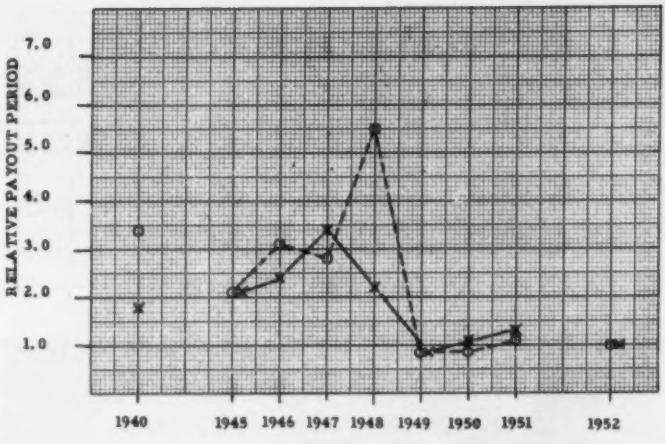


Figure 2 (above). Relative Payout Periods for Coking vs. Fuel Oil. (Basis: Current Investment and Taxes with Past Posted Prices 1952 Payout Equal 1.0). Broken-line curve for Gulf Coast, solid-line curve for Group 3.

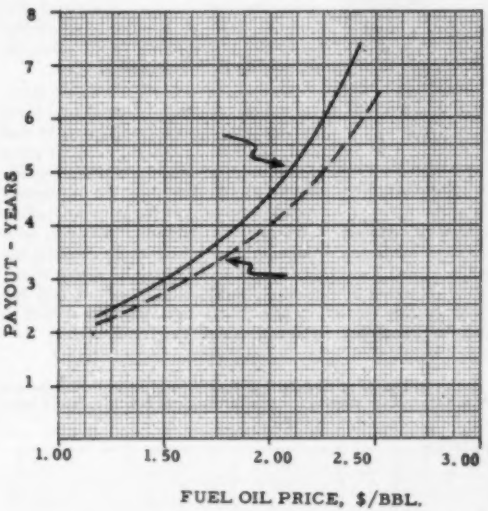


Figure 1 (left). Variation of Payout with Fuel Price (After 52 Percent Federal Taxes). Solid-line curve, Coke at $5 per ton. Broken-line curve, Coke at $10 per ton.

To further indicate the effect of price structure on the economics of coking, Figure 2 has been developed showing the relative payout for the petroleum price structures existing during recent years. In developing this chart, the payout has been calculated for current investments and tax rates with the current payout being assumed to be 1.0. (A $5 per ton coke price is used throughout these calculations.) It will be noted that prior to World War II and immediately after removal of price regulations, the economics of coking was substantially more unfavorable than with current prices. During the past few years the price of fuel oil has remained, relatively, low enough to justify its conversion to light products.

The economics of coking as an alternate to increased crude processing capacity is developed in Table 3. For this approximate analysis it is assumed that the octane quality of the gasoline produced by the two alternates is identical. For most cases, this is substantially true. Since the cracking requirements for the two alternates are essentially the same, the major difference in investment is the difference in cost of a coking unit and a topping unit. For the situation assumed, this difference is estimated to be 1.1 million higher for the coker. With current (Group 3) prices (fuel oil at $1.50 per barrel) the net savings for coking, based on 52 percent federal tax rate, is estimated to be $1.3 million annually for a payout of 0.9 years. When viewing the economics of coking on this basis, the items of importance are the difference in price between crude oil and fuel oil. The effect of this differential, for the case illustrated, is shown in Figure 3. With

TABLE 3

Appraisal of Coking Vs. Crude Processing

	Increase Over Base Case Dollars per Year		
	Coking	Crude Processing	Coking Over Crude
Realization*			
Gasoline	7,140,000	7,140,000	0
Fuel Gas	340,000	140,000	200,000
Fuel Oil	440,000	1,180,000	—740,000
Coke	530,000		530,000
	8,450,000	8,460,000	—10,000
Costs			
Crude Oil	0	6,900,000	—6,900,000
Topped Crude	4,110,000	0	4,110,000
Coking	300,000	0	300,000
Topping	0	130,000	—130,000
Cracking	485,000	485,000	0
	4,895,000	7,515,000	—2,620,000
Gross Savings	3,555,000	945,000	2,610,000
Net Savings (52% Taxes)	1,930,000	630,000	1,300,000
Investment	$5,800,000	$4,700,000	1,100,000
Payout—Years	3.0	7.5	0.9

* Gasoline—10 cents per gallon. Fuel Oil—$1.50 per barrel. Crude Oil—$2.65 per barrel.

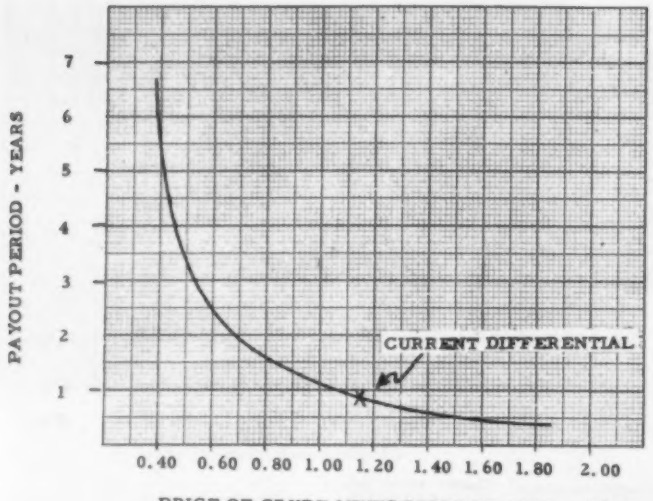


Figure 3. Variation of Payout with Crude and Fuel Prices.

differentials between crude oil and fuel oil of about $0.60 of greater, coking is particularly attractive as a means of increasing gasoline production. With differentials less than about $0.60 per barrel, the payout can be definitely marginal.

Rather than attempt to project future price structures in the industry, we have again resorted to past prices as an indication of how the economics of coking might appear with passage of time. Figure 4 gives the relative payouts with current investment and tax laws and for price structures existing during the past seven years. Following the rapid increase in prices during 1946-1947, the price of fuel for a period was equal to or exceeded the cost of crude and hence coking was extremely uneconomical. Since 1949, when the current price structure tended to stabilize, the economics of coking versus processing additional crude has remained relatively attractive.

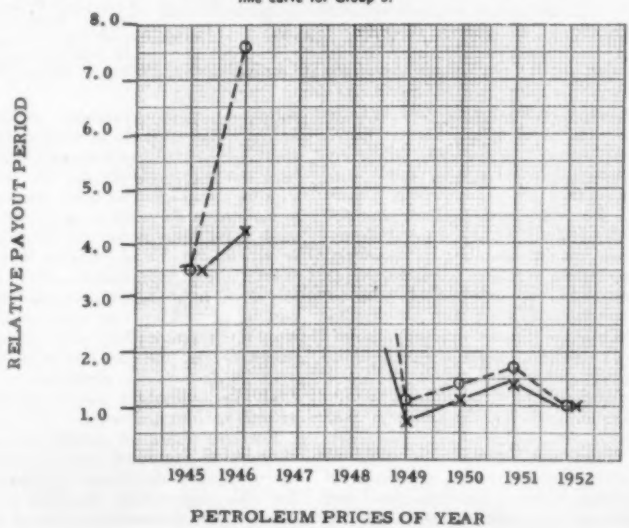
As indicated earlier the philosophy utilized to appraise coking has been one of increasing production of light products rather than one of reducing heavy fuel production. Thus far only production of gasoline has been considered. With low sulfur reduced crude for coking, roughly 50 percent of the coker gas oil produced could be utilized, after mild treating, to increase diesel fuel production. The light coker gas oil itself or light catalytic cycle oil from cracking the coker gas oil might also be utilized as No. 2 fuel oil. The economics of these alternates, of course, would depend upon each refiners' feed stock and product demand. However, it is important to recognize that the coking process is one method of substantially increasing both gas oils and gasoline production from crude.

When coking high sulfur reduced crude, the refiners' sulfur problems may be substantially intensified. Sulfur which is usually concentrated in the crude bottoms will appear proportionately high in coke still naphtha. Where topped crudes containing 2 to 3 weight percent sulfur are involved, this might necessitate further refining of coke still gasoline to reduce its sulfur content to the desired level. Our Company has experienced this situation and has not found the problem insurmountable or of such cost as to materially affect the economics of coking.

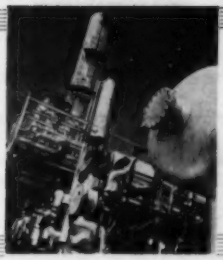
These economic calculations were based on the delayed coking process. This process farms and accumulates the coke production in place alternately in two or more large vertical pressure vessels from which the coke is then removed usually by high velocity water jets. Coking may also be accomplished by the continuous contact coking process. It is not our purpose in presenting this appraisal of coking to promote any specific coking process. Our appraisal is, of course, based on the process with which we are most familiar. In the opinion of the authors, however, the choice of coking processes is secondary to the selection of coking as a refining process.

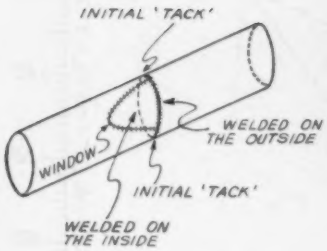
Needless to say, the economic story for coking as here presented could not be expected to apply universally for each and every refinery. Peculiar price situations, product demand, equipment availability, or the universal problem of capital funds greatly affect each specific situation. However, with the continually increasing demand for light products and the apparent shortage of crude, coking will, we feel, assume a much more prominent spot in the refinery of the future.

Figure 4. Relative Payout Periods for Coking vs. Additional Crude. (Basis: Current Investment and Taxes Past Petroleum Prices 1952 Payout Equal 1.0.) Broken-line curve for Gulf Coast, Solid-line curve for Group 3.



MAINTENANCE And OPERATION How To Do It—



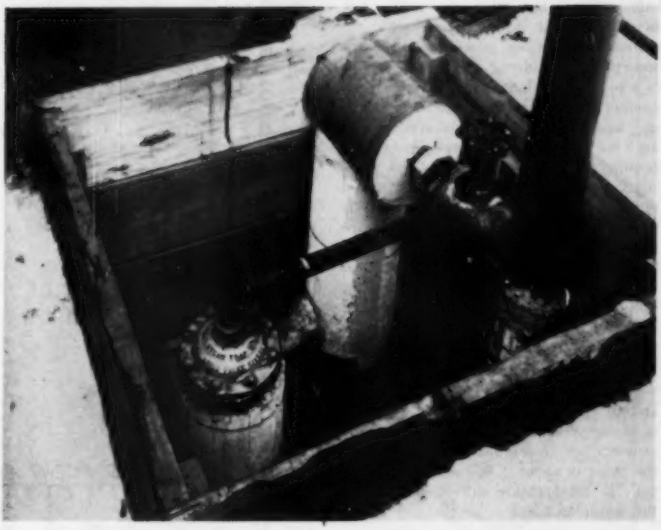


By cutting a window after initial tacking, lower weld may be made on the inside.

Close Quarter Welding Solved by Welding Inside and Outside

WHEN repairing furnace tubes, or replacing pipe sections, very often welding must be done in locations where it is impossible to reach the under-side of the tube or pipe. For instance, if three pipe lines run parallel to each other on the ground, and are very closely spaced, it is impossible to weld completely around the outer circumference of the pipe in the center.

The problem may be solved, however, as shown in the sketch. The new pipe or tube section is cut to the correct size and then tacked in place at two spots. Then a window is cut in the opper half of the pipe. Using the window, the lower half of the pipe is welded in place from the *inside*. The window is then welded back in, and the upper half of the pipe is welded in place on the outside. This hint was submitted by Milton Beychok, Long Beach, Calif.



Protecting Outdoor Traps From Freezing

VERY cold weather plus unprotected outdoor traps can add up to trouble. Instead of merely worrying, here are some things you can do to prevent them. First, the principal causes for freeze-ups:

1) The discharge line from an outdoor trap is so long that the condensate has a chance to cool to the freezing point before it is returned to the boiler. With the line frozen, the trap cannot discharge. Water in the trap can then cool and freeze.

2) The trap has been left full of water after steam is turned off, either accidentally or on purpose.

To prevent freezing, precautions can be taken as follows:

Where the condensate is returned to the boiler, insulate the line to the trap, the trap itself and the line from the trap, with weatherproof insulation. In addition, in order to prevent any possibility of temporary air binding, larger than standard bucket vents should be used. Trap discharge lines should pitch down to the return header.

Where condensate is discharged to the atmosphere, insulate the line to the trap and the trap itself. The discharge line from the trap should be kept as short as possible and pitch away from the trap. This prevents ice from forming on the end of the discharge pipe.

Where unusually severe weather conditions are encountered, install the trap below ground level. As in the sketch, the ideal job is to put the trap in a box or a piece of tile with a suitable cover to prevent injury to personnel as well as provide additional protection against the cold.

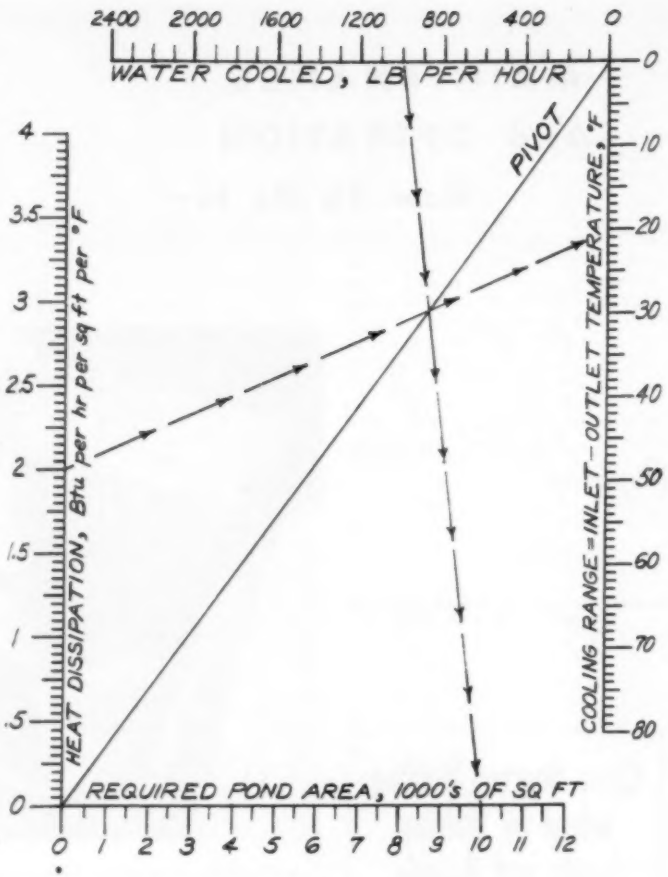
Nomograph for Cooling Pond Area

COOLING ponds do not find as much use as they formerly did in petroleum plants, but they are still used to some extent in temporary pumping stations and similar jobs. Also, they are sometimes considered during the design of a petroleum plant that requires water-cooling facilities to see how they "stack up" against other methods accomplishing the same end—spray ponds and cooling towers of various designs. This chart permits easy calculation of required pond area, the physical unit which is sometimes the deciding factor in choice of cooling method. Of course, other factors—heat-dissipating capacity, final water temperature obtainable, cost, etc., influence final choice. However, required area can be a deciding factor, especially when plant area is limited. Use the chart like this.

Example: Cooling water enters a pond at 100° F. and is to leave at 80° F. What is the area needed to cool 1000 pounds of water per hour if heat dissipation from the pond is about 2 Btu per square foot per °F. temperature difference between the water and air?

Solution: Enter the chart at the left and from a heat dissipation of 2 Btu per square foot per hour per °F. draw a straight line through the cooling range of 100° — 80° = 20° F. Then from 1000 pounds per hour of water cooled, on upper scale, draw a straight line through the intersection of the first line with the pivot line. On the lower scale read 10,000 square feet, required pond area.

Note several facts about this chart. Where water quantity to be cooled exceeds values on the upper scale, divide water quantity by a convenient number and solve as described. Multiply area found by the number previously divided into quantity of water cooled.



Example: Suppose that 10,000 pounds per hour of water were to be cooled under the same conditions as stated above. What is the required pond area?

Solution: Water quantity of 10,000 pounds per hour is beyond range of chart. So it must be divided by a convenient number. A value of 10 is one such number; divide by 10 and solve as before. Then required area = 10 (10,000) = 100,000 square feet.

Heat dissipation of a cooling pond depends on several factors—air temperature, wind velocity and relative humidity of the air. For pond design heat dissipation has been found to run from about 2 Btu per square foot per hour per °F. difference in air and water temperatures in winter to 4 Btu per square foot per hour per °F. difference in air and water temperatures in summer. Pond depth has little effect on cooling effectiveness if pond area is sufficient. Note that the final water temperature cannot be lower than the air's wet-bulb temperature and that moderate cooling ranges, 10° to 20° F., are usually more desirable than large cooling ranges.

This nomograph was prepared by T. G. Hicks, Hicksville, N. Y.

Maintenance and Operation Ideas Are Worth Money
Send your HOW TO DO IT suggestions with photos or sketches to Editor, Petroleum Refiner, Box 2608, Houston, Texas.

NOTE

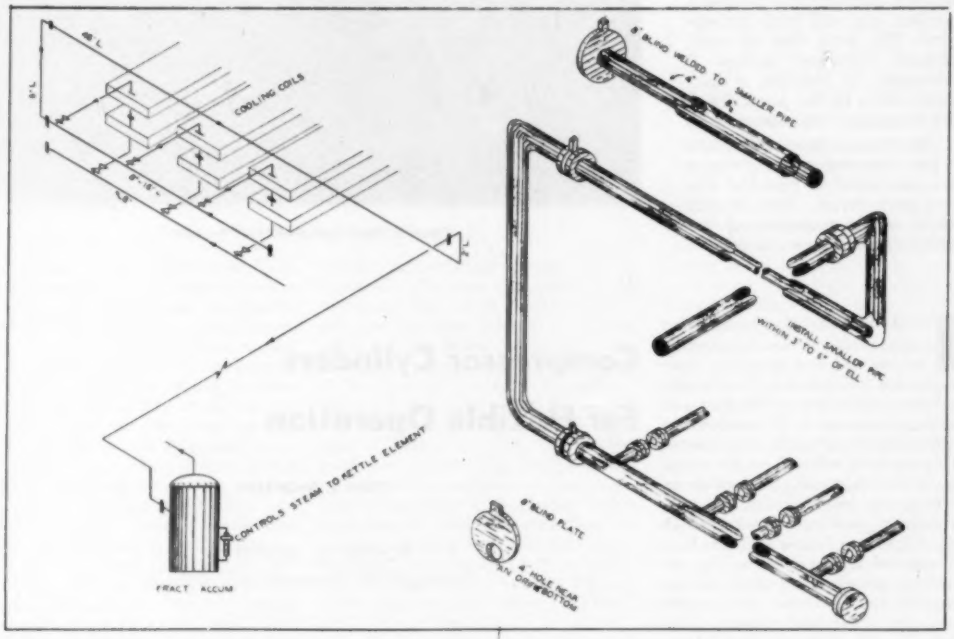
The maintenance and operation hints on the following page are the prize winning "Operation Kinks" from the Panhandle-Plains Regional Meeting of NGAA, Amarillo, Texas, November 20, 1951.

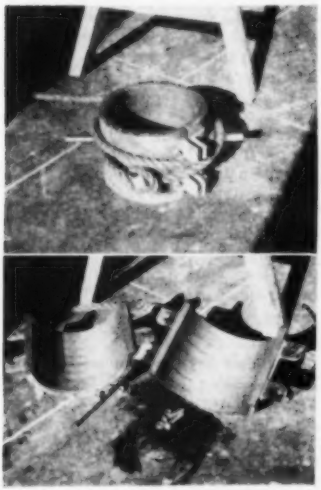
Eliminating Liquid Trap in Coil Outlet Headers

IN A DEETHANIZER coil outlet header line to the overhead accumulator, liquid collected in the header and carried over into the accumulator in slugs. Since the liquid level in the accumulator controlled the steam to the column kettle, the result of any sudden variation of the accumulator level upset the operation of the fractionator. Application of two methods to increase the line velocity resulted in a steady flow, as shown in the sketch.

First, a blind plate with an orifice cut in the lower section was placed in the line. The second method, somewhat more elaborate, involved the use of a blind plate with a smaller size line pipe welded and extended to within a few inches of the vertical riser.

—C. Glyn Mitchell
Phillips Petroleum Company
Odessa, Texas





Grinding Ridges on Engine Crankshaft

WHERE ridges on an engine crankshaft were too hard to file off, a lapping collar was improvised as shown in the photograph. The collar was machined from cast iron exactly to the size of the piston rod bearing. Spiral grooves were turned in opposite directions from each end inside the collar. Bolts fastened through lips are used for adjusting the pressure against the shaft. Ropes attached to opposite sides of the collar complete the assembly.

In use, the lapping compound is placed in the collar before clamping it on the crankshaft and the bolts are tightened to give the desired pressure. With a man on each rope, the collar is see-sawed for about ten minutes. The engine is then jacked over one-eighth revolution and the grinding procedure is repeated. The spiral grooves tend to work the lapping compound back and forth in the collar without permitting loss through either end. As the crankshaft is ground down, the bolts are periodically tightened on the collar. Lapping compound is cleaned out and the shaft is checked with a micrometer approximately every 30 minutes.

—I. S. Hammack
Shell Oil Company
Notrees, Texas

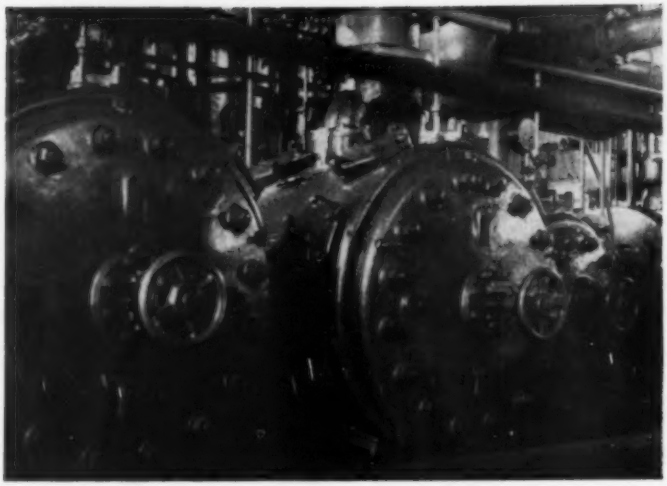


Figure 1. Hand-Controlled Head Pockets.

Compressor Cylinders For Flexible Operation

Part I. Selection

ROBERT S. RIDGWAY
Standard Oil Company of California

WHEN BUYING new compressors, the cylinders can be selected to meet the immediate condition; or by careful planning, they can often be chosen with sufficient flexibility to follow a considerable pressure decline and still load the engine. The high cost of compressor cylinders makes it profitable to conduct a thorough study of the possibilities for increased flexibility.

The various factors that limit the compressor cylinder size are discussed in Part I of this two-part series. Part II will show some examples of the effect of clearance control.

IN SELECTING the gas handling equipment for natural gasoline plants, all too often the compressors are purchased with cylinders which have been sized so that they will load the power end of the machines at the immediately anticipated pressures.

It is the rule, rather than the exception, to find that gas pressures in an oil field are anything but constant, particularly suction pressures which normally fall to follow field declines and reduced trap pressures. The absorption pressures are usually the one exception to this rule and provide one source of constant pressure which is common to most gasoline plants. Discharge pressures to gas lift operations, for "kicking off" wells, and for injection programs, as a rule gradually alter with time. Some transmission lines require higher delivery pressures at seasons of heavy demand and consequent higher pressure drop.

Foresight Needed

Hence, it behooves the engineers charged with responsibility for selecting the compressor equipment to foresee, as far as possible, the widest range of pressure fluctuations which can be anticipated, and to prepare for it by selecting cylinders which can do the best job of straddling this range. In fact, there is no reason why such ranges should not be exceeded, up to the limitations of the cylinders in question; for in many instances it is possible that machines may be moved from declining to new fields and all the flexibility which can be obtained may prove to be of great value at some later date. The value stems from the ability to use existing cylinders to load the compressor unit, rather than find it necessary to purchase new cylinders when conditions are changed. New compressor cylinders are a very heavy item of expense in themselves, and the usual slow delivery time extends the period when the compressor cannot be fully loaded; hence, the loss due to underloading is still further increased.

It is the purpose here to show:

- The limitations of compressor cylinder size and factors affecting a reasonable selection; and
- The practical methods of control of load and capacity of compressor cylinders.

In arriving at the number of compressors, cylinder size and arrangement to handle the various services in a plant, it is the normal procedure to determine the total horsepower required for the work of compression and then to decide upon the type and size of unit after determining how the various features of the units offered fit into the requirements of the plant. The total horsepower should not be divided into increments so large that the shutdown of one unit would seriously cripple the field, unless a standby unit is anticipated. Where possible, it is much more satisfactory to have "balanced" units, viz., have all services be handled by each compressor. However machines with places for more than five compressor cylinders are extremely rare, so frequently this arrangement cannot be worked out simply.

The unit having been selected, the supplier then proceeds to provide cylinders which will exactly handle the volumes of gas which are proposed. Such an installation provides no "rubber" for either changes of pressure,

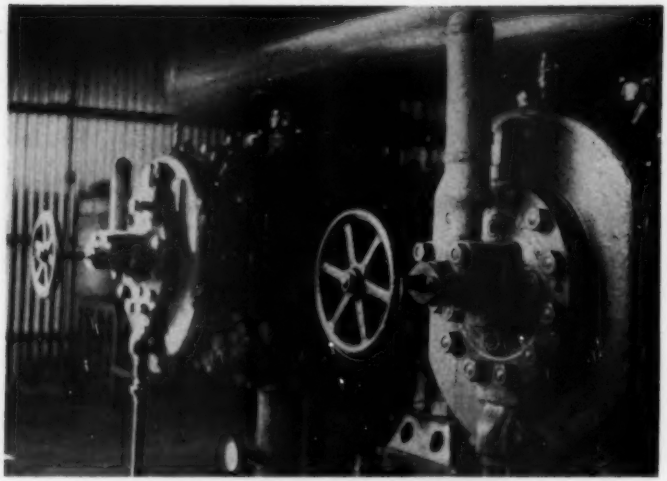


Figure 2. Hand-Controlled External Pockets.

noted above, or the flexibility of being able to reduce the volume of certain services and replace that horsepower with volume picked up on other services. It is even possible that, during peak periods, it may be an over-all economical move to overload the compressor by 10 to 20 percent—if the machine will take it—weighing the value of the increased revenue supplied by carrying the overload during a peak or emergency period, against the cost of increased maintenance and possible damage due to the overload. There have been many such emergency periods when such revenue can well afford to pay handsomely for the increased maintenance. The installation of cylinders which have been sized only for the proposed load is unable to fit into such a program.

Clearance Pockets

Compressor cylinders with capacities larger than are required to handle stipulated volumes are equipped with one or more clearance pockets so that their capacity is made equal to that required without the loss of power. Reference to a volumetric efficiency curve indicates the effect of clearance vs. the ratio of compression. From this we realize the difficulty in obtaining much control by this method of using added clearance when ratios are low, such as are commonly experienced in gas transmission lines. With the exception of such services, however, low ratios are fortunately the exception and not the rule. Hence, the gasoline and pressure maintenance plant operator seldom experiences this handicap.

Clearance pocket installations are made in a wide variety of methods—some being more convenient than others, and some having very definite handicaps. Perhaps the oldest pocket to be used was one in which the pocket or chamber was located within the outer cylinder head, and access to this pocket was controlled by a bevel-seated valve. The stem projected through the head and the valve could be opened and closed at will. (Figure 1). This type of pocket is widely used today, particularly where it is desired to load or unload the cylinder at any time. The limitation on such a pocket is that its volume is fixed; and, therefore, the cylinder is equipped to handle two—and only two—loads. Large cylinders can, of course, have several pockets, each with its own valve. One compressor manufacturer provides a similar valve in the cylinder head which opens and closes a passageway to a threaded or flanged opening. (Figure 2.) To this opening is attached a pocket, usually made of welded pipe fittings, of a size required to fit the load. This type of pocket is quite flexible, in that the external pocket can be removed and altered at will in a short time by a good welder.

Elimination of Control Valve

Under perhaps the majority of gas plant conditions, compressor loads are usually changed only to keep pace with field declines or a rearrangement of capacities, so that, normally, the requirement of opening and closing the pocket is infrequent and the control valve in such cases can be eliminated. Some manufacturers leave a throat or passageway through the outer head. Some provide a throat on each end of the cylinder barrel so that, if large clearance volumes are required, they can be divided between the two ends of the cylinder, eliminating the necessity for one pocket which might be of an unwieldy size. Fabricated pockets, as noted above, are readily built in the field to permit the compressor to follow the field requirement. When the field conditions change enough to warrant a change in compressor thruput, a short computation by the engineers and some welder's time and testing are

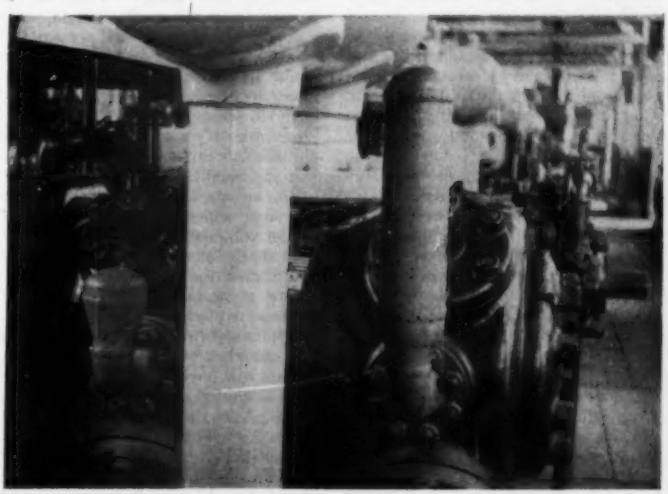


Figure 3. Two External Pockets on Opposite Ends of Cylinder.

all that is required to stretch or shrink the compressor cylinder to fit its new condition. It frequently works out to be an advantage when using cylinders with two external pockets to make one approximately twice the size of the other. (Figure 3.) It is surprising how many times one such pocket can be reused when changes become necessary.

Cylinders with throats as described above should come equipped with full clearance plugs, so that the plugs can be installed whenever necessary and thus reduce the cylinder to its minimum clearance for maximum capacity. Variable pockets are obtainable (Figure 4) providing for plugs which, in effect, serve as an outer cylinder head which can be retracted to increase the clearance by any incremental value to predetermined limits. Such pockets are quite useful but are also quite expensive, and some types have the handicap of requiring so much space beyond the cylinder head as to block the aisleway and thus become an undesirable obstacle in the plant.

While on the subject of providing for clearance, it should be mentioned that arrangements for this feature are easy when buying new equipment but frequently raise a problem to the operator with cylinders which were supplied with no provisions for adding clearance. Where such an addition is necessary on an old cylinder, there is often at least one of several ways in which it may be accomplished. Cylinders of relatively small diameter may have small clearance pockets connected through the indicator ports. The limitation of 12,000 cubic feet per second actual velocity of the gas in the connecting tube seems to be an accepted value, though we have seen no losses shown on indicator cards taken when throat velocities were considerably in excess of this factor. By contacting the manufacturer, the diameter of the boss which was cast into the cylinder can often be obtained, and it is probable that the ½-inch pipe size indicator hole can safely be enlarged to ¾-inch pipe size. It is also quite possible that both sides of the cylinder were equipped with bosses for indicator connections, even though only one side was drilled. We have equipped many of our smaller cylinders with four indicator connections, drilled and tapped for ¾-inch pipe size, to which we have attached 4 spherical clearance pockets (Figure 5).

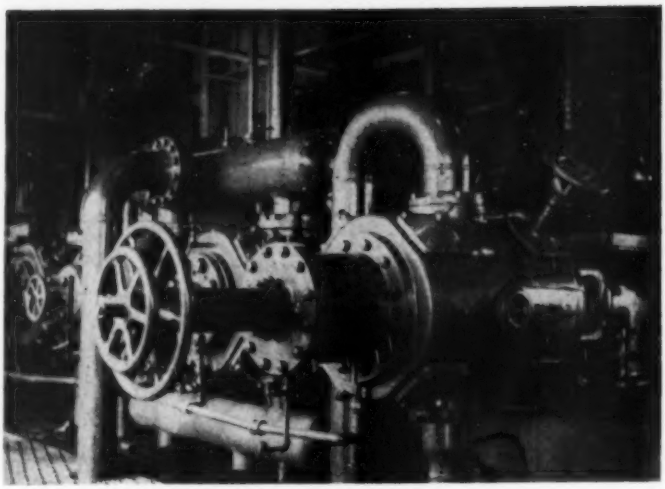


Figure 4. Variable or Adjustable Clearance Pocket. Note inlet valve lifter on frame end of cylinder.

Where this method of adding clearance is inconvenient, a false ring can be made and installed between the outer head and the cylinder barrel. This is more costly, as it usually requires a new complement of through-bolts for the cylinder. Where the piston is cored so that the internal volume works out to be useful in obtaining the required clearance, this method can be used. An excellent discussion of this method of control has been prepared by W. R. Barrett.[3]

If additional cylinder capacity is a desirable feature when purchasing new equipment, the logical question then becomes "how much?" There is no simple answer here. One might wish that a blanket 10 or 20 percent increase in capacity on every service could be specified, and indeed this factor has been used very advantageously in some instances. On a recent large order for compressors, the probabilities of capacity shift were such that the manufacturers were asked to quote on machines equipped with cylinders which could be loaded at design volumes and pressures, but by field change of clearance, any cylinder could pick up 10 percent more capacity at design pressures. This arrangement provided a nice flexibility. More often, however, the various stages will not work out so nicely, and other factors will have to be considered.

In natural gasoline operations where many plants, declining fields, and new fields are concerned, it makes for excellent standardization to make a study of the various pressure range "brackets" which might be encountered and attempt to select a "standard" size of cylinder which can fulfill the requirement of the fluctuations of pressure within each service. Sometimes—for reasons which are to be discussed later—one size of cylinder cannot cover a complete range, and a large and smaller cylinder must be decided upon. Such planning pays off, in that as more equipment of the same type is purchased, a collection of cylinders of interspersed sizes will be gradually accumulated. This will be most convenient for interchangeability and will greatly reduce the inventory of spare parts required to maintain the operating cylinders.

Limiting Cylinder Sizes

There are three primary factors involved in limiting cylinder sizes. These are: horsepower, rod loading, and pressure. There are other factors too, such as physical size, which enter the picture on some machines when two large cylinders cannot be located side by side. The supplier should see that the major limitations are not exceeded; but, to be conversant with them, we will discuss them briefly. Most manufacturers of angle compressors have an upper limit of horsepower which they want taken from any one compressor throw. For example, on an 800-hp. angle unit, which is built with four compressor throws, the ideal cylinder balance would be to have each cylinder requiring 200 hp. Pipe line stations, where the gas is single-staged and all cylinders are alike, are frequently arranged in this manner. Gasoline plants are not usually so accommodating, and often we find it convenient to have cylinders with loads as low as 100 hp. to as

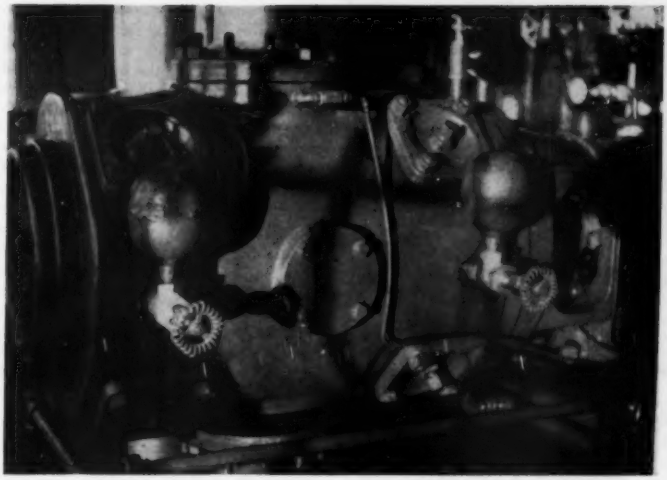


Figure 5. Small External Pockets Operated through ¾-inch I.P.S. Indicator Connections.

high as 300 hp. arranged on such a unit. Sometimes it is convenient to take the full load of a machine built for four compressor cylinders from three cylinders, with a blank cover placed over the fourth space. Depending upon the design of the machine, the manufacturer will have a maximum horsepower per throw which he will permit on his unit. These factors on four-throw compressors usually vary from 35 to well above 50 percent of the total power for any one throw. The higher the factor, the more flexible the machine becomes—at least from this limitation.

Rod Loading

Rod loading is frequently the governing factor on the upper limit of cylinder size. All compressor manufacturers have a maximum total load which may be imposed upon the piston rod in tension, and frequently a higher rating when the rod is in compression. Piston rods are usually designed to handle a unit tensile stress of around 10,000 psi, which, although it appears low for the high quality steels normally used in rods, actually is a good practical upper limit, considering the type of stresses which are imposed and the endurance limit of the material. All of the other parts of the machine which are affected by rod loading are usually designed around the rod, such as the allowable total stress in the frame, the strength of the connecting rod, connecting rod bearing bolts, crosshead, and unit pressures in the bearings. Any one of these may be the limitation which dictates a specified rod loading, rather than the rod itself. The weakest member is thus protected by a limiting total pressure on the rod. Some manufacturers require a greatly reduced rod loading when the cylinder is single-acting. This is done, not for the sake of the rod, but to reduce the bearing loading when the pressure is all in one direction and lubrication is therefore more difficult.

Rod loading is frequently assumed to be the difference between suction and discharge pressure, multiplied by the piston area. This is not too far from wrong in large cylinders where the area of the rod is a negligible proportion. For small cylinders, however, the rod area makes a substantial difference; hence, it is necessary to obtain the compression load by actually multiplying the piston area by the discharge pressure, and subtracting therefrom the product of the suction pressure by the piston area less rod area. The tension load must be computed in a similar manner, calculating the load times the net area in tension and subtracting the load by the net area in compression. Identical pressure differentials at different pressure levels will produce different rod loadings. For this reason, it is necessary to calculate rod loading at each anticipated pair of operating pressures to insure that this limitation has not been exceeded.

In some machines, rod loading is usually the first "bottleneck" which limits cylinder size; hence, it is wise to make this calculation early in the survey for cylinder selection.

* * *

Maximum safe working pressure of the cylinder frequently prevents the use of what otherwise might have been a very adequate cylinder to meet a new requirement. It usually pays to check the various patterns which a manufacturer can use for any one size of cylinder, for he may have several, each permitting different working pressures. Sometimes it may be necessary to sacrifice certain features like low gas velocities through the valves, clearance throat location, or other physical handicaps in order to obtain higher allowable working pressures and sometimes the sacrifice is not worth the gain. However, it is short-sighted to require a working pressure only adequate for the initial job if higher pressures could be obtained merely by checking into the availability of such a cylinder. It might be said in this regard that sometimes the ability to go to higher pressures will permit the use of a smaller safety valve for the same capacity, thus effecting a saving. Computations to indicate the effect of higher working pressures should be done in conjunction with both the horsepower and rod loading calculations to indicate where pressure in excess of that permitted by the other limitations would be of little value.

Standard Working Clearance

It is wise to evaluate the effect of the standard working clearance of the cylinder. Some manufacturers make a determined attempt to design cylinders with a very low normal clearance. Others sacrifice this feature for other considerations. Obviously, if the normal clearance is low, a cylinder of a given size or displacement will handle more gas than a similar cylinder of larger clearance. This becomes more pronounced as the ratio of compression is increased. To compensate for higher standard clearances, cylinders of larger diameters must be selected for the same capacity. Increased size in itself is of no particular disadvantage unless, as has been discussed above, the increased size runs into the limitation of rod loading or reduces the maximum safe working pressure. When these limitations occur, low standard clearance is of prime importance.

REFERENCE

[1] "Operating Flexibility for Process Gas Compressors," W. R. Barrett, PETROLEUM REFINER, January, 1949.

General view of Eastern States' new Platforming unit during construction in Houston. The charge and Intermediate Furnaces are on the right, with feed and Product Fractionators to the left.

Eastern States Builds Platformer In Record Time

H. M. MARTIN

Eastern States Petroleum Company
Houston

EASTERN STATES has just completed a reforming unit addition to its Houston refinery in record-breaking time. The new Platforming unit was on stream in successful operation in only six months after ground was broken, and only seven months from the time the idea for the venture was first conceived.

Such exceptional speed in construction was accomplished through careful planning, expert supervision, and expeditious cutting of all engineering red tape. Usually many months of engineering work precede the start of construction. On this project, however, practically all of the engineering was done simultaneously with construction. In this article, H. M. Martin, Eastern States' chief engineer, tells how it was done.

IN THE latter part of June, 1951, the board of directors of Eastern States Petroleum Company authorized the signing of a license agreement with Universal Oil Products Company for a 6200 barrels-per-day Platforming unit. This unit was to be the first of the UOP Platformers designed for the production of aviation base stock and the management of Eastern States was very anxious that the unit should be built in the least possible time. January 15, 1952, was set as the on-stream time for the unit.

In accordance with past practices it was decided to build the unit with the maintenance and construction forces of the refinery. These forces were to be augmented with sub-contractors if the manpower needs could not all be supplied by Eastern States' men. It was realized that if any kind of construction record was to be made, work had to be started before engineering details could be completed.

At a conference with UOP in Chicago it was decided that Eastern States would do the mechanical design work on the unit and that UOP would do the process design on elements of the new unit that were peculiar to the platforming operation. Eastern States own process group was to do the design on the sections of the unit that were typical of any refinery installation.

From a preliminary flow diagram a layout of the unit was made and sent to the field engineer. On July 24 ground was cleared for the unit and excavation was started for the as-yet-undesigned foundations. Engineering work was sublet to five local engineering firms which worked under the direction of the Eastern States' Engineering Department. Foundations for the fractionating towers and condenser platforms were designed first. Due to very poor soil condition it was necessary to drive piling under all major items of equipment. In less than a week the piling layout and foundation for the fractionating section had been designed and the drawings sent to the field engineer. The construction forces began work on these foundations at once, and from this time on the construction force was either supplied with drawings or the work was field engineered by members of the company's Engineering Department.

At the start of construction the policy was established that at no time was work to be stopped because of haggling over minor engineering details. Eastern States' has several competent refinery engineers and these men were given authority to issue instructions to the construction superintendent when detailed drawings were missing. The confidence of the company in these men was well justified, for as the detailed engineering work proceeded it was found necessary to change only a very few of their many on-the-spot decisions.

Within the first ten days of the program it was evident that there would be two main items of equipment which would be difficult to obtain by the time they would be needed in the accelerated construction program. These were 1) the Platformer reactors or catalyst chambers and 2) the special hydrogen compressors. It was determined that it would be impossible to procure quickly new steel plating for the construction of the reactors. As these vessels were peculiar to the platforming unit UOP was asked to design them. This company provided Eastern States' with sketches of the reactor vessels which indicated that four vessels of 5½-foot diameter and 2½-inch wall thickness would be required.

An expediting group, set up at Eastern States at the start of this project, was given the job of locating used vessels which could be altered to make the reactor vessels. The expeditors were successful in locating three thermal cracking reaction chambers within 250 miles of the Houston refinery. These vessels were inspected by the refinery inspection department and found to be of suitable wall thickness. These vessels contained enough material to make the four reactors with the exception of two heads. Two heads of exactly the right specifications were located in Oklahoma, and these were purchased and shipped to the Houston fabricator who built the reactors. The Houston shop which fabricated the vessels worked on a 24 hour a day basis building these four catalyst chambers and they were delivered within three months.

Meanwhile, the expeditors were busy looking for compressors. As the gas end of the compressors had to be of a special design, using non-lubricated carbon pistons running in an iron liner, it was hopeless to look for a machine that would suit the requirements exactly. The process group de-

termined the horsepower requirements of the compressors and the expeditors began looking for compressors of this horsepower with the hope that they could convert the gas end of the machines to the special service. Two 600-hp. gas compressors were located at a gas pipe line station in Kansas that was being shut down. These compressors were in good condition but the gas end of them was for low-pressure service. The manufacturer was called and agreed to design and build new gas ends for these engines within three months. The engines then were purchased and shipped to Houston where they were installed minus the compressor end and when these parts arrived from the factory and were installed, the engines were ready to run.

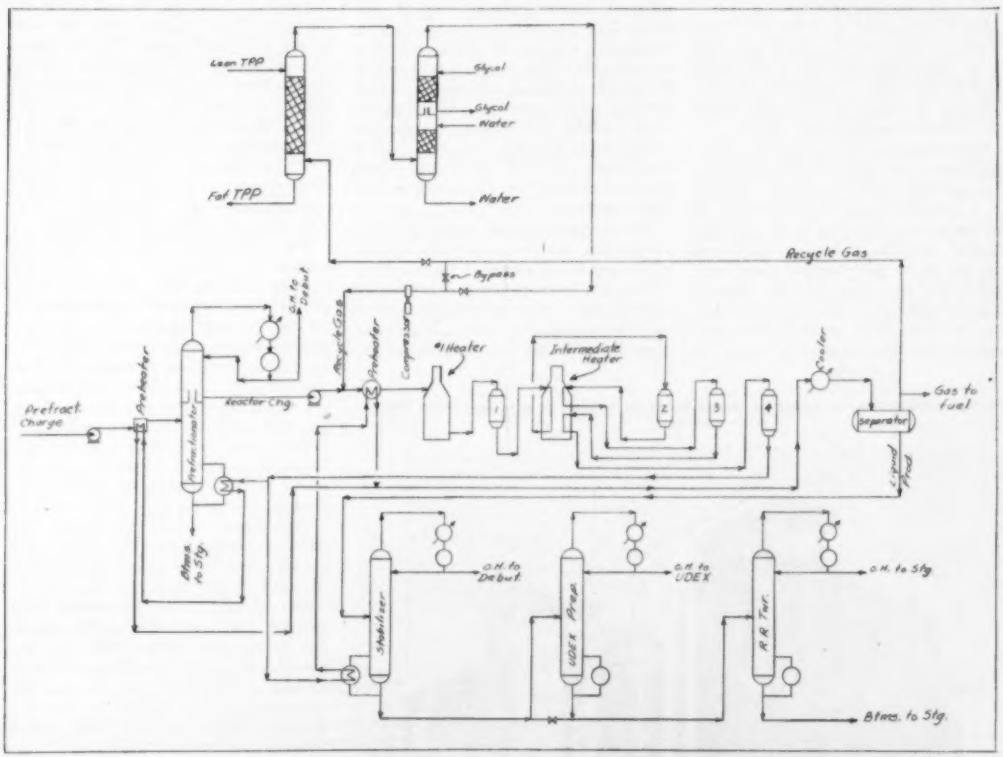
There are four major fractionating towers in the unit. As soon as the diameter, length, and working pressure of these vessels was determined the construction of tanks of this size was contracted with two local fabricators. Skirts were designed for these towers also, but nozzling and the tray design had to be left until later. The design of the trays for the towers was turned over to a reputable tray manufacturer. This company was told that Eastern States must have the trays in the minimum of time and they were allowed to adapt standard trays to fit the design conditions of the tower. The towers were shipped to Eastern States minus the nozzles which were added on the job by the Eastern States mechanical forces. As soon as the nozzles were in the towers they were erected on the foundations and the internal tray supports were started into them on a twenty-four hour, seven day a week basis. By the time the internal tray supports were in place the trays were in Houston and the traying of all four towers proceeded at the same time.

At the start of the design of the unit it was obvious that there would be some difficulty in balancing out the design of the heat exchange equipment. The condensers on the towers were clear cut and orders for them were placed within a few weeks after approval of the unit. The design of the other heat exchange equipment was not so simple and it was decided that we should purchase a large number of fin tube units which could be used with great flexibility in building this unit. An order was placed for approximately 200 fin tube heat exchanger units and by the time they were delivered the process group had worked out the details of their installation. A few of the units were left over, but they will be used elsewhere in the refinery.

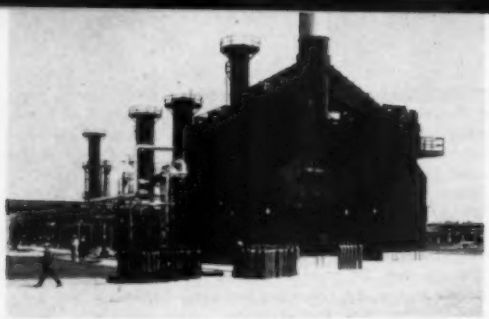
Characterized by its ability to produce either aviation fuel or aromatics, the process flow at Eastern States' new Platformer near Houston also differs from previous units by the use of four reactors instead of three. The unit is designed to process 7000 bpd of a straight-run gasoline to produce heavy platformate and the charge stock to an aromatics recovery unit.

Referring to the flow sheet below, the straight-run gasoline is fed to a prefractionation tower where the reactor charge is taken as a sidecut. Combined with the recycle hydrogen gas, this charge passes through a heat exchanger and heater to the four reactors in series, and intermediate heater being provided for heating the charge between units. The reactor effluent enters the product separator with the bulk of the gas going to the recycle compressors and the liquid to a stabilizer.

The bottoms from the stabilizer, which is operated as a depentanizer, are charged to a feed preparation tower where the Udex charge is removed overhead and the heavy platformate is removed at the bottoms to be rerun before going to storage.



Construction proceeded at record-breaking pace through elimination of all unnecessary engineering red tape. Much engineering work was done in the field at the site of construction.



Shown in foreground are some of the many hydrogen cylinders used to charge the unit with hydrogen prior to startup.

In this unit alloy piping had to be used in any case where hydrogen existed at a temperature of over 500°. The expediting group began to purchase 4-6 chrome pipe from many sources and stock pile it at the refinery. Also, a local pipe fabricator was contacted and told that he would be given the job of fabricating the alloy pipe if he could obtain a certain amount of the material. One engineering firm was chosen to do the design work on the alloy piping and this particular bit of engineering was pushed in order to get the drawings in the hands of the fabricator. This pipe was fabricated on a two-shift basis and was delivered in January.

After December 1, 1951, the construction work on this unit was put on a seven-day-per-week schedule. Most of the work was done on the day shift but on several critical jobs work was continued around the clock.

Subcontractors were used by Eastern States' to do part of the work. The cooling tower was built entirely by a subcontractor. The erection of the towers was handled by a qualified rigging concern and electrical work was put in by an electrical contractor under the direction of the Eastern States' electrician supervisor. In addition to these firms, several other contractors supplied groups of labor to perform specific jobs on the unit. At least two-thirds of the work on this unit was performed by Eastern States' own maintenance forces, however.

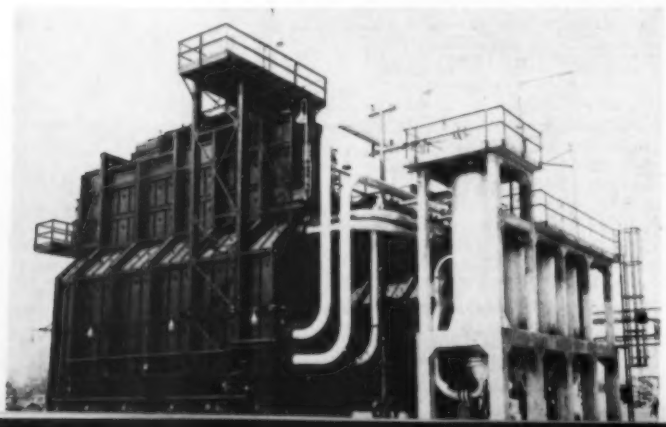
The Platforming unit was built on an old fill from the dredging of the Houston ship channel. As has been mentioned earlier, it was necessary to drive piling under every large piece of equipment in this unit. The top soil was a loose and varied mixture of gray clay and silt. During the lightest rain the ground became so soft that work was almost impossible. The original plans had called for the paving of the unit when construction was completed, but as work became more difficult because of the mud it was decided to pave the area at once. The entire unit was paved with four inches of concrete. This work was handled by a subcontractor who made exceptionally small pours in order that his work would not interfere with the other construction. This slab, when completed, enabled the construction workers to carry on efficiently during bad weather.

The instrumentation of the unit was completely conventional with all instruments being supplied by one firm. Before any instruments were purchased agents from several reliable instrument manufacturers were called in and frankly told that the supplier of the instruments was going to be selected on a delivery basis. The manufacturer who offered the best delivery makes a complete line of instruments and was able to handle the complete job. The field representatives of this company did much of the engineering on the instrumentation of the unit. The instruments were delivered on time and completely installed by the time the rest of the unit was completed.

Where possible, older designs from other parts of the refinery were used in the new unit. The control house was built from the same prints as the control house of Eastern States' catalytic cracker. The condenser stands were copies of condenser stands used in the gas concentration unit. It was known that good engineering had gone into design of this equipment and as the services were almost identical no reason was apparent for doing additional engineering when any changes in the finished design would be minor. UOP checked the design work of the Eastern States' process group. Some changes were recommended by UOP and these were usually agreed to.

The Platformer unit was put on stream on February 1, 1952, six months and six days from the time ground was broken and approximately six and one-half months after the first definite process information was given to the Engineering Department. Top management of Eastern States' gave the engineering and construction people full authority in the construction of this unit. At no time was any job halted by red tape involved in getting front office approval to make purchases. Approval of design was left to the Engineering Department. The newly organized expediting group did an excellent job of procuring delivery of hard to get materials. The enthusiasm of all people connected with this job was remarkable and the seven-day weeks were worked with very few complaints. It was possible to do such a fast construction job because the management was willing to trust the refinery personnel with this major construction job.

The four catalytic reaction vessels are located beside the furnaces so as to shorten the length of hot lines.



Catalytic Cracking of High Nitrogen Charge Stock

Part II. Discussion of Results

J. W. SCHALL and J. C. DART
Houdry Process Corporation, Marcus Hook, Pa.

Generalized Cracking Characteristics

Once-through Cracking of Virgin Gas Oil

THE product distributions obtained when cracking the virgin heavy gas oil over clay catalyst at 900°, 950°, and 970° F. in once-through operation were presented in Figure 1 as a function of conversion. In once-through operation at constant conversion, the effect of cracking temperature on the yields of coke, dry gas, and C_4 cut are normal. An increase in temperature decreases the yield of coke, increases the yield of dry gas, and does not affect the yield of C_4 cut. With some stocks and catalysts, an increase in temperature will increase the yield of C_4 cut at constant conversion, however, the increase in yield is small.

One of the outstanding cracking characteristics of this high nitrogen content charge stock is that the cracking temperature does not affect the C_4-free gasoline yield at constant conversion over the range of conversion (32-56 volume percent) and temperature (900-970° F.) covered by the experimental data. This absence of a temperature effect on gasoline yield is supported by previous data obtained when cracking other high nitrogen content stocks, a light gas oil containing 0.17 percent nitrogen and a heavy gas oil containing 0.3 percent nitrogen, over various cracking catalysts in moving bed pilot units. C_4-free gasoline yields obtained when cracking the above light gas oil over clay, Type M, and bead catalysts at various cracking temperatures are shown as a function of conversion in Figure 4. The experimental data can be defined with a common curve. More specifically, these data show that at constant conversion the gasoline yield is independent of cracking temperature from 800° to 900° F. and is independent of the type of cracking catalyst.

Based on the data obtained in this investigation and those shown in Figure 4, it can be assumed that at constant conversion the gasoline yield obtained when cracking a high nitrogen content charge stock is independent of temperature over the range from 800° to 970° F. within conversion limits of 19 to 56 volume percent. An entirely different effect is obtained with essentially nitrogen free charge stocks. For example, when cracking East Texas heavy gas oil at 55 volume percent conversion, an increase in cracking temperature from 850° to 950° F. decreases the gasoline yield 3.5 volume percent.

Because of the absence of a temperature effect on gasoline yield, temperature is a very important process variable in the cracking of a high nitrogen content charge stock for maximum gasoline yield. A specific example of this is illustrated in Table A below for a case in which the coke burning capacity of a kiln is limiting and where sufficient heat can be supplied to the reactor to maintain the required cracking temperature when cracking the high nitrogen content heavy gas oil. The data were taken from the smooth curves of Figure 1. When cracking temperature is progressively increased from 900° to 950° F. and from 950° to 970° F., at constant coke yield, gasoline yield in-

THIS ARTICLE. Part I of which appeared in the March issue, shows results of a moving bed catalytic cracking pilot plant investigation. The charge stock used was a 21.2° API gravity, 910 F.E.P. gas oil containing 0.4 weight percent nitrogen. Also included are the results of a single run made to determine the cracking characteristics of a first pass catalytic gas oil obtained from moving bed cracking the heavy virgin gas oil.

This, Part II, discusses the generalized characteristics of high nitrogen content charge stocks and the data obtained in this study are made applicable to other high nitrogen content charge stocks by means of combination charts.

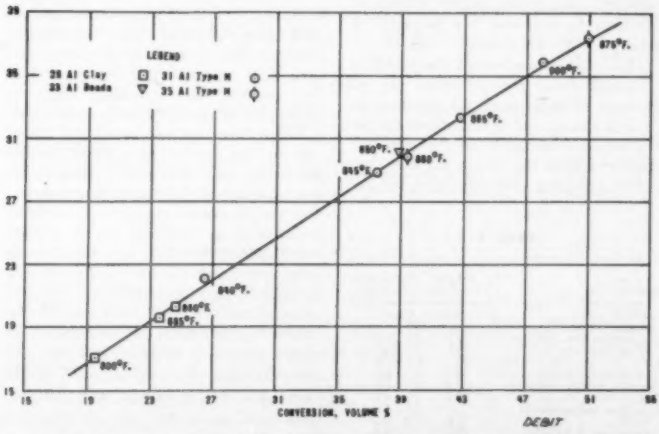


Figure 4. Gasoline Yield as a Function of Conversion. Once-Through Moving-Bed Cracking High Nitrogen Content Light Gas Oil-0.17 Percent Nitrogen. Cracking Temperatures Noted.

TABLE A

Coke Weight, Percent	....	6.0	....
Temperature, °F.	900	950	970
Conversion, Vol., Percent	39.7	44.7	47.4
C_4-Free Gasoline (378° F. @ 90 Percent), Vol. Percent	30.4	33.3	34.9
Gas-Oil, Volume Percent	60.3	55.3	52.6
C_4 Cut, Volume Percent	5.8	6.4	6.8
Dry Gas, Weight, Percent	5.0	6.8	7.9

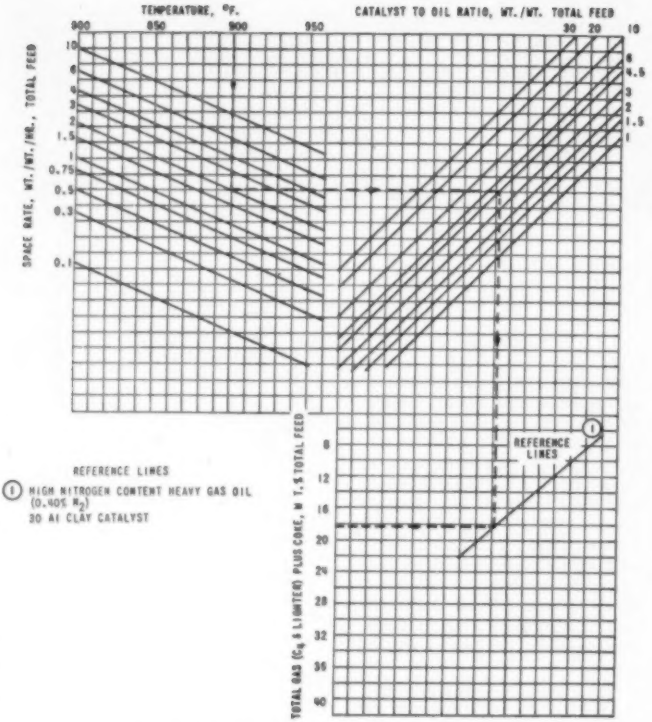

TEMPERATURE, °F.
CATALYST TO OIL RATIO, WT./WT. TOTAL FEED
SPACE RATE, WT./WT./HR., TOTAL FEED
TOTAL GAS (C4 & LIGHTER) PLUS COKE, W T.% TOTAL FEED
REFERENCE LINES
REFERENCE LINES
① HIGH NITROGEN CONTENT HEAVY GAS OIL (0.40% N2)
30 A.I. CLAY CATALYST

Figure 5. Effect of Process Variables on Yield of Total Gas Plus Coke.

creases 2.9 and 1.6 volume percent, respectively. This increase in temperature increases conversion and yields of C_4 cut and dry gas.

An increase in cracking temperature can also be used advantageously to increase the extent of cracking, and therefore increase gasoline yield, in the case where limitations on space rate and catalyst to oil ratio in an existing unit do not permit full utilization of the coke-burning capacity of the kiln.

Once-Through Cracking of Catalytic Gas Oil

An indication of the cracking characteristics of a bottoms-free catalytic gas oil was obtained by cracking this oil over clay catalyst at 900° F. in the six liter fixed bed pilot unit. The catalytic gas oil was prepared from that obtained when cracking the virgin gas oil over clay catalyst at 900° F. and 33.9 percent conversion in the moving bed unit. A comparison of the product distributions and gasoline inspections obtained when cracking the virgin gas oil and the catalytic gas oil is shown in Table B. The octane ratings of the gasoline obtained from the virgin gas oil were taken from the smooth curves of Figure 2.

At essentially the same gasoline yield, the catalytic gas oil produces higher yields of C_4 cut and dry gas at a slightly higher conversion level. However, the coke yield obtained with the catalytic gas oil is lower than that obtained with the virgin gas oil. At constant coke yield, higher yields of gasoline, C_4 cut, and dry gas will be obtained with the catalytic gas oil.

The octane numbers of the gasoline produced from the catalytic gas oil show an advantage of 1.4 numbers in the F-2 rating and 2.7 numbers in the F-1 rating over those of the gasoline produced from the virgin gas oil.

The cracking characteristics of the catalytic gas oil appear to be as good as those of the virgin gas oil. Furthermore, gasolines produced from the former have higher octane ratings.

TABLE B

STOCK	Virgin Gas-Oil	Catalytic Gas-Oil
Catalyst	30 A.I. Clay	
Cracking Temp., °F.	900	
Conversion, Vol., Percent	33.9	36.6
C_5-Free Gasoline, Vol. %	26.9	26.6
Total Gas-Oil, Vol. Percent	66.1	63.4
C_4 Cut, Vol. Percent	4.7	6.2
Dry Gas, Weight Percent	3.9	4.6
Coke, Weight Percent	5.1	4.6
Gasoline Inspections:		
RVP	5.6	6.5
Octanes: F-2 Clear	77.9	79.3
F-1 Clear	89.7	92.4

Recycle Cracking of Virgin Gas Oil

The product distributions obtained from the three recycle runs included in this investigation were shown in Figure 1. At constant conversion, an increase in recycle ratio does not affect the yields of coke and C_4 cut, decreases the yield of dry gas, and increases the yield of gasoline. In effect, an increase in recycle ratio at constant conversion produces gasoline at the expense of dry gas. However, at constant conversion the gasoline yield increases only 1.2-2.2 volume percent when recycle ratio is increased from 0 to 0.5 and increases only an additional 0.8 volume percent when recycle ratio is further increased from 0.5 to 1.0.

This small increase in gasoline yield with an increase in recycle ratio probably could not justify commercial recycle operation with this charge stock or any other high nitrogen content charge stock when the decrease in cracking capacity accompanying the increased recycle ratio is considered. The best way to process a high nitrogen content charge stock for maximum gasoline yield would be to crack the virgin gas oil in once-through operation and separately crack, either catalytically or thermally, the first pass catalytic gas oil. This is particularly apparent when considering the fact that the cracking characteristics of the bottoms-free, first pass, catalytic gas oil are as good as the virgin gas oil.

To illustrate the above point, a hypothetical case has been prepared in which the product yields obtained from recycle cracking are compared with those obtained when separately cracking the virgin and catalytic gas oils. It is assumed that a refiner has two moving bed cracking units, a 10,000 barrel-per-stream-day unit with a coke burning capacity of 6900 pounds per hour and a 6000 barrel-per-stream-day unit with a coke burning capacity of 4100 pounds per hour. The virgin gas oil charge for catalytic processing is assumed to be 10,000 barrel-per-stream-day. In Case I, both units are cracking the virgin gas oil in recycle operation with an internal recycle ratio of 0.6. In Case II, the entire 10,000 barrel-per-stream-day of virgin gas oil is cracked in Unit 1 in once-through operation and 6000 barrel-per-stream-day of bottoms-free, first pass, catalytic gas oil obtained from Unit 1 is cracked in once-through operation in Unit 2. In both

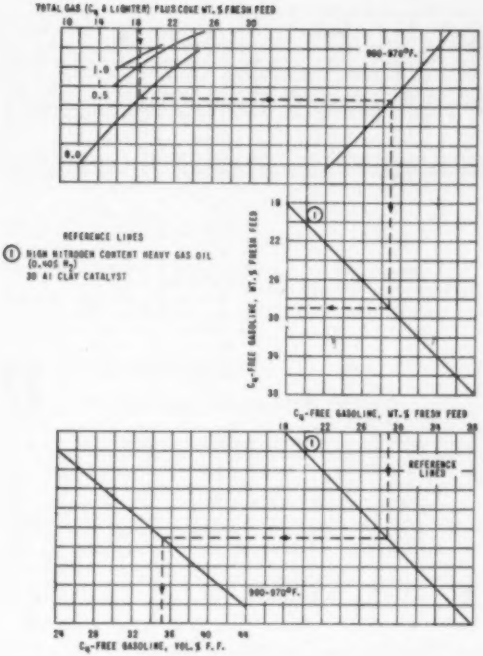

TOTAL GAS (C_4 & LIGHTER) PLUS COKE WT. % FRESH FEED
900-970°F.
REFERENCE LINES
① HIGH NITROGEN CONTENT HEAVY GAS OIL (0.405 N_2)
30 AI CLAY CATALYST
C_5-FREE GASOLINE, WT. % FRESH FEED
C_5-FREE GASOLINE, VOL. % F. F.
REFERENCE LINES

Figure 6 (left). Relationship between the Yields of Total Gas plus Coke and C_5-Free Gasoline.

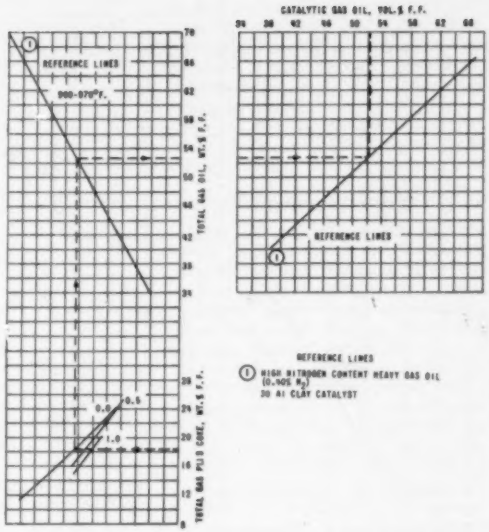

REFERENCE LINES
900-970°F.
TOTAL GAS OIL, WT. % F. F.
TOTAL GAS PLUS COKE, WT. % F. F.
CATALYTIC GAS OIL, VOL. % F. F.
REFERENCE LINES
① HIGH NITROGEN CONTENT HEAVY GAS OIL (0.405 N_2)
30 AI CLAY CATALYST

Figure 7 (above). Relationship between Yields of Total Gas Plus Coke and Total Gas Oil.

cases, the coke burning capacities of the kilns are limiting.

A summary of the product yields obtained from Case I and Case II is shown in Table C. Maximum gasoline yield can be realized when separately cracking the virgin gas oil and catalytic gas oil. This case shows an advantage of 610 barrel-per-stream-day additional gasoline over the internal recycle operation at a constant total coke burnoff of 11,000 pounds per hour.

It is realized that the hypothetical comparison shown in Table C probably would not exist in practice since, if a refiner had two cracking units, both units would undoubtedly be of equal size. In that case, the second unit could be used to crack the first pass catalytic gas oil in an internal recycle operation or additional virgin feed of a different type (preferably low nitrogen content) could be used to make up the balance of the total feed to the second unit. Nevertheless, the cited example serves to illustrate clearly the advantages occurring from separately cracking virgin and catalytic gas oils.

TABLE C

Comparison of Recycle Cracking vs. Once-Through Cracking of Virgin Charge and Catalytic Gas Oil

Virgin Charge:
10,000 bpsd high nitrogen content heavy gas oil (0.4 wt. % N_2)

	Unit No. 1	Unit No. 2
Total thruput, bpsd	10,000	6,000
Coke burning capacity, lb./hr.	6,900	4,100

	CASE I		CASE II		
	Unit 1	Unit 2	Unit 1	Unit 2	Units 1 & 2
Type of Operation	Recycle	Recycle	Once-through	Once-through	....
Charge, bpd:					
Virgin Gas Oil	6,250	3,750	10,000	....	10,000
Internal Recycle Stock	3,750	2,250	....	....	....
1st pass catalytic Gas Oil	....	....	....	6,000	6,000
Total	10,000	6,000	10,000	6,000	16,000
Product Yields:	Combined Products				Combined Products
C_5-Free Gasoline (375° F. @ 90%), bpsd	3,830		2,750	1,690	4,440
Gas Oil, bpsd	4,560		6,000*	3,600	3,600
Syn. Tower Bottoms, bpsd	500		500	....	500
Total C_4s Cut, bpsd	700		520	340	860
Dry Gas, Lbs./Hour	7,440		5,800	3,950	9,750
Coke, Lbs./Hour	11,000		6,900	4,100	11,000

* Charge to Unit 2, Case 1.

Application of Data

It is often necessary to estimate product distributions and/or the effect of the process variables on product distribution when cracking various types of charge stocks. This can be done readily by means of combination charts with appropriate stock and/or catalyst reference lines. Previously published combination charts[1, 2] can be used for all charge stocks which are essentially nitrogen-free. As has been previously discussed, the cracking characteristics of high nitrogen content charge stocks differ from those of nitrogen-free stocks in two principal respects, namely, 1) absence of temperature effect on gasoline yield at constant conversion, and 2) the effect of recycle ratio on product distribution. Therefore, the combination charts presented in the aforementioned papers cannot be used to estimate the product distributions obtained when cracking high nitrogen content charge stocks.

The data obtained in this investigation using a heavy gas oil containing 0.4 weight percent nitrogen have been used as a basis for constructing combination charts applicable to high nitrogen content charge stocks. These combination charts are shown in Figures 7 to 11 with reference lines for this particular heavy gas oil. Guide lines illustrate the use of the charts. Reference lines for other high nitrogen

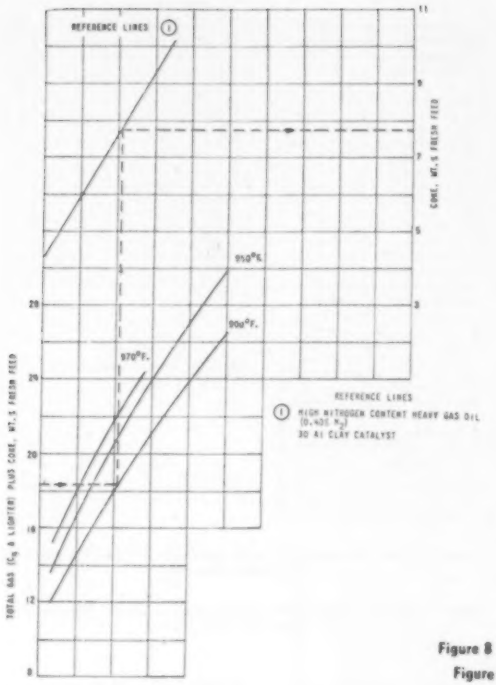


Figure 8 (above, left). Relationship between Yields of Total Gas Plus Coke and Coke.

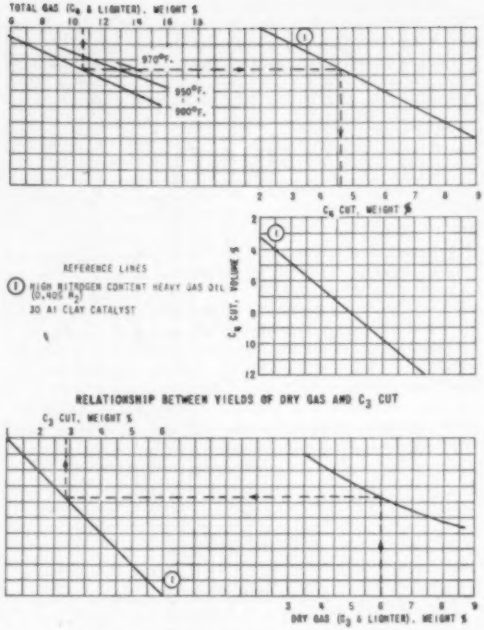

TOTAL GAS (C4 & LIGHTER), WEIGHT %
970°F.
950°F.
900°F.
C4 CUT, WEIGHT %
REFERENCE LINES
HIGH NITROGEN CONTENT HEAVY GAS OIL
30 AI CLAY CATALYST
C4 CUT, VOLUME %
RELATIONSHIP BETWEEN YIELDS OF DRY GAS AND C3 CUT
C3 CUT, WEIGHT %
DRY GAS (C2 & LIGHTER), WEIGHT %

Figure 9 (above, right). Relationship between Yields of Total Gas and C4 Cut.

content charge stocks can be defined by two or more experimental points. The applicability of the combination charts to other high nitrogen content charge stocks has been checked and found suitable.

There is an important point to consider in the application of these combination charts to other high nitrogen content charge stocks. If the stock has been pretreated for nitrogen removal, there is a distinct possibility that the pretreatment may selectively remove the types of nitrogen compounds which are most deleterious to catalytic cracking. In that case, even though the total nitrogen content of the pretreated stock remains high, the cracking characteristics of the stock will change markedly and may be similar to those of nitrogen-free stocks.

Conclusions

1) When cracking a high nitrogen content charge stock, temperature has no effect on the C_4-free gasoline yield at constant conversion. Therefore, temperature becomes a very important process variable in the cracking of high nitrogen content charge stocks for maximum gasoline yield. If the coke burning capacity of a kiln is fixed and is limiting, gasoline yields can be increased by increasing cracking temperature.

2) Cracking a high nitrogen content charge stock in a recycle operation shows very little yield advantage over a once-through operation. When recycle ratio is increased from 0.0 to 1.0 at constant conversion, C_4-free gasoline yield increases only 2-3 volume percent and coke yield remains the same.

3) The cracking characteristics of a bottoms-free first pass catalytic gas oil are as good from the standpoint of gasoline and coke yield relationships as those of the virgin gas oil. Octane ratings of the gasoline obtained when cracking catalytic gas oil are 1.4 and 2.7 numbers higher in the F-2 and F-1 ratings, respectively, than those obtained from the virgin gas oil.

4) The best way to process a high nitrogen content charge stock from the standpoint of product distribution is to crack the virgin gas oil in a once-through operation and then separately crack the first pass catalytic gas oil.

5) A series of combination charts have been presented to permit the estimation of product distributions and the effect of process variables on product distribution when cracking the high nitrogen content heavy gas oil used in this investigation. These combination charts are adaptable to other high nitrogen content charge stocks by establishing appropriate reference lines with two or more sets of experimental data.

End of Part II and series.

* * *

Certainly! Small Plants Need Industrial Relations Programs, Too

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IN THE matter of industrial relations, you don't have to be big to be good. Large corporations possess no monopoly on good personnel policies and practices. Small plants can have just as modern and progressive industrial relations set-ups as large ones. Nor does it cost a lot of money to achieve this desirable result. All over the country there are small and medium sized organizations which enjoy excellent industrial relations with employees. This end does not come about by accident but is rather the result of careful management planning.

Some small plants have mistakenly thought that personnel work is a luxury which they could not afford. The fact is the absence of effective personnel work is something which cannot be afforded.

Most large corporations have gone into personnel programs in a big way. Some of this effort has resulted from the fact that size has caused management to lose contact with employes, some from the great sub-division of work which occurs in many set-ups and which in turn reveals necessity for careful training. Quite a lot of it in the big companies has resulted from labor unrest, so causing management to pay attention to the factors underlying that unrest. In addition the big companies have usually thought out their personnel set-ups as parts of a larger program and hence have been more prone to follow up certain pre-determined policies. Salesmen of personnel aids have been more prone to call upon the large companies than upon the small which in turn means that many of the personnel specialists in large companies have received stimulation or education from such salesmen or have adopted some of the devices offered. Finally it is true that large companies have been more willing than small concerns to employ the services of personnel specialists in the development of their programs.

Industrial relations is not something which can be delegated to one person in an organization. It is rather a way of management thinking and as such the task must be spread over a great many individuals. Therefore it is possible for foremen and top management of smaller plants to have just as good an industrial relations program as is the case with the big company. The desire to have it is the important thing.

In fact, smaller organizations have certain inherent advantages which make the task of setting up a good industrial relations program easier than for the industrial giants. Frequently the small company is either housed under one roof or is located within a circumscribed area making it possible for top management to see what is going on and to reach readily all levels of supervision and frequently all levels of employes. The intimacy of such person-to-person contact has marked value in any personnel program. In the small plant, too, there will usually be but a few supervisors who must be made personnel conscious, whereas in the large plant it becomes quite a task to get some supervisors to give more than lip service to many of the ideas which top management wants to put across.

MANY SMALL industrial organizations think that industrial relations or personnel relations programs are too complicated for the small plant. Here is an article which emphasizes that no organization, large or small, can afford to ignore the problem of personnel relations.

For the small plant the industrial relations program should be simple and direct. To this end it is recommended that the program be based on four principal factors: selection, training, incentives, and supervision. How to apply the basic fundamentals to the small plant is ably handled by the author, who has counseled in this field over the past several decades.

Four Major Factors

Many persons regard the task of setting up a personnel program as an intricate problem because it seems to have so many aspects. However, experience over several decades has shown that we are dealing principally with four major factors:

1) Selection, 2) Training, 3) Incentives, and 4) Supervision.

The management of any small plant which will set up personnel policies and practices to support these four activities, and to move them forward as integrated parts of the management program, will find that it is developing an excellent industrial relations program. The reader will note that we are here using the words industrial and personnel relations interchangeably although in some situations a distinction is made between them, which need not be observed here.

Different plant managements will conceive their personnel programs as aimed at different objectives but most would agree that at least these three are fundamental:

1) To reduce labor costs per unit of production.

2) To increase the stability of the working force.

3) To foster friendly relations between management and employes.

Between present practices and these three objectives, there lies a maze of policies and procedures.

In attempting to improve the situation, the present status of industrial relations in any given plant must be used as a spring board. It is generally not possible in human relations to change the status at one fell swoop. Employes are resistant to change and will look with suspicion upon new programs. Hence it is better to evolve them rather than suddenly to toss over-board old practices and substitute something entirely new.

Too often policies are merely crystallized practices instead of carefully thought out guides to management action. Too often when an executive is queried as to the wisdom of a certain policy, he will fall back upon the assertion "It's a company policy," as though that answered all questions and perforce made it a right policy. No, it is desirable to examine present practices and policies to see if they are meeting present day conditions. It

is from some such starting point as this that the evolution must occur.

Selection

You've heard the theory: jobs should fit employes like peas to the pod, gloves to the hand, neckties to the personality. When you hire an employe, he can try on the job for size, like a new suit or a king's crown. If it doesn't fit, get a new employe.

That is sheer nonsense. Neither jobs nor employes are static, clearly defined and unchanging. When a new man comes into a job, both he and the job change in subtle ways. Discard the square peg in the square hole theory. Select men for:

1) *Character* equal to the rigors and temptations of the work.

2) *Temperament* suited to the nature of the task, and to fellow employes.

3) *Ability* sufficient for the mental, skill and physical requirements.

It would seem trite to establish as a company policy the selection of capable workers. Yet if any company announces such a policy and then really tries to implement it, it will bring upon itself many corollary practices which can be of benefit to the organization. Some of these practices are suggested below:

1) *Question the sources of labor supply.* Expand them in number and improve them in quality. To rely on a few sources of labor supply such as employment agencies or friends of present employes can merely mean that you are in a rut as far as selection is concerned. Sit down and list all possible sources of labor supply for your working force and begin to explore each one.

2) *Use two interviews at least.* Because most individuals have high confidence in their powers to select and reject employes, and further because scientific tests have shown that such confidence is greatly overrated, it seems desirable to check the employment interviewer with the foreman, or to check the foreman with the superintendent, in order to get two views upon applicants who come anywhere near meeting company requirements.

3) *Use aptitude tests.* By now the question of whether aptitude tests are of value in selection is academic. Those who have used them for years and those who have made scientific studies have clearly demonstrated that if properly used they can be a great help. True enough they are more rejective than selective. That is, those who fail to pass the tests would most likely fail on the job whereas those who pass the tests may succeed or may fail depending upon many other factors. Hence to use them as screening

devices seems sensible. There are tests available for a great many different occupations and for a great many situations. For example, tests of intelligence and tests of interest may suggest the general direction in which an employe should move in your organization. On the other hand, a stenographic test or a test of blueprint reading may be so specific as to indicate only whether an applicant possesses the proficiency he claims, suggesting nothing about his promotability.

4) *Get references.* This is usually a big weakness in employment in small companies. Quite often small companies are located in communities where the employing interviewer feels satisfied that he knows enough about the applicant and sometimes this is true. But in general it should be recognized that the former employer already knows more about an applicant and how well he can perform than you can hope to know after all your interviews and all your tests. Hence it seems the height of folly to ignore this knowledge. Personal interview of the former employer is best designed to elicit the desired information but telephone calls can be almost as good. Leave the form letters, asking for reference information, to the big companies. If you are small and are forced to get written information, do it with a personally written letter and it will more likely get you honest information. Generally form letters get casual, sometimes cavalier, treatment!

One way of looking at this question of selection and particularly of obtaining references is this: a capital investment of $60,000 at 4 percent would cost your company $2400 per year. If you were hiring an employe at $200 per month you in essence would be taking on a capital investment of $60,000. If you were purchasing something for your boiler plant or for your production department which represented a $60,000 investment you would certainly take the trouble to inquire of other users how that investment had performed in the past!

5) *Get a physical examination.* In the first place this may be useful to save you compensation costs later on. However, it primarily insures that you will have employes of physical vigor equal to the requirements of your task. If you do not follow this practice you are likely to take on the rejections of neighboring companies. Also such a practice enables you intelligently to hire persons with physical handicaps which in no way will interfere with performance. Experience has shown that handicapped persons, properly adjusted to their tasks, are likely on the average to be superior to the non-handicapped.

One of the phases of physical examination which has come into prominence in recent years is visual testing. So many jobs are dependent for their successful performance on good coordination of eyesight with muscles that the visual tests are well indicated in many occupations. In giving these tests it is not sufficient to use the ordinary chart which is placed on the wall twenty feet from the applicant. Ocular science has passed beyond this stage these many years, only many employers and even some physicians do not know it. You should look into the apparatus available for employment departments and determine which is best suited to your needs. Not only will good eyesight permit you to get higher production in many occupations but also it may avoid accidents, errors and absenteeism.

6) *Induct new employes properly.* The first week of employment is a very important one. The employe feels strange and his impressions of his new job, his new boss and his new company are likely to be formed at this point. Only a week ago his own mind had not been committed as to whether he would accept the job. Up to that point he has probably been treated with considerable courtesy because there is some doubt on the part of the interviewer as to whether the applicant wants the job. However, after the die has been cast, many companies seem to toss the new employes to the wolves —the wolves being the indifference of supervisors and other employes and the strangeness of the new surroundings. If you want to avoid this situation set up a system whereby sponsors are designated in each department. New employes are turned over to the sponsors and given the task of easing the break-in period. Such a plan not only makes the new employe feel at home more quickly but it also makes the sponsors feel that they are part of management.

Perhaps you will want to prepare an employe handbook, but since the content of such a handbook changes rather rapidly and since the cost of the handbook can become fairly large

if you do it right, you may accomplish much the same result by putting into the hands of the sponsor a check list of things which he is to cover with the new employe.

Training

The second factor in setting up a good personnel program is training.

Start with supervisory training which is a never ending task. Even if your supervisors last year went through a comprehensive course of training in the art of foremanship, you will find that this information drops away from them rather rapidly, that new supervisors are now in the picture, that much of the original material was not grasped. Hence if you did nothing but repeat the first course you would still be ahead, but since this is likely to bore some of your supervisors you have to change the format from year to year, even though you may be covering much the same ground again and again. If top management will provide supervisors with proper information and reasoning about the economics of business, those supervisors in turn will be in good position to answer some of the fallacious arguments and incorrect statements which will be thrust at them. However, if top management feels that economics is a hush-hush subject which should not be discussed with supervisors, then it must be prepared to take the consequences of such fallacies on the part not only of rank and file employes but also of supervisors themselves.

Employe training should be specific and practical. This is particularly true for new employes, where on-the-job training or vestibule training directly preparing for the work to be done, will be of greatest benefit to the employe and to the company.

Every refiner has been exasperated at some new employe who forgets or violates specific instructions. Firing such employes does no good, for their replacements do the same—or equally dumb—stunts. (Also, some refiners continue to offer equally dumb training.)

You may save some dollars and gray hairs, if you will:

Tell him what, why and when,
Show him how, where and who.
Check him again and again,
Until you are sure he can do.

You see, it's a two-way communication. In telling and showing, the flow is from you to the employe, but in checking the flow is reversed—the employe tells you what, why and when; shows you how, where and who.

Try it the next time you have an instruction task on your hands. Find out if you "can do."

Some managements have the mistaken notion that they can avoid training either by hiring individuals away from their competitors or by paying higher rates or both. In this instance they are fooling themselves because then the cost of training may lie in losses of their own employes to those self same competitors or in the higher hourly rates which must be paid. It is far better to assume that the cost of training cannot be avoided and to pitch into a practical training program for on-the-job duties, which program will be repeated with each new man who comes into the picture. In formulating such a program there should be a high degree of supervisory participation so that the supervisors will believe that the training is practical. Yet it is difficult to merely throw the burden of training upon the supervisor when he has so many other duties to do. Here the size of the company is likely to be the determining factor. In very small organizations there is little choice other than to have the supervisor break in a new employe and possibly for management to check the supervisor to make certain that it has been done well.

As employes settle into their jobs and become established with the company, other types of training can be offered, such as courses on economics or courses designed to develop employes for promotion. Some of these more generalized courses have the effect of making the employe realize that management is really interested in his welfare and so of binding him closer in his loyalty to the management.

The study of misfits represents a combination of selection and training. By locating the misfits, by analyzing their weaknesses and by attempting to overcome these weaknesses through training, many an employer can salvage worthwhile employes who otherwise would either be lost or would be in jobs where they would contribute little. If someone in the organization has developed a considerable facility with aptitude tests, these tests can be useful in the analytic work.

If an organization is not big enough to have a personnel manager specialized for some of these functions, nevertheless the functions have to be performed by somebody and management may have to spread them among two or three persons in the executive ranks. The fact that such executives have other duties should not be allowed to prevent them from absorbing and applying the newer techniques in selection, training and other phases of industrial relations.

Incentives

Our third phase of a well-developed industrial relations program was labeled incentives, a large term that embraces both non-financial and financial incentives. It is easy to be misled by the prevalent accent on wage rates in employe relations. Many an employer has assumed that he can buy loyalty merely because employe pressures are generally expressed in terms of cents-per-hour or of fringe benefits. Yet no employer has ever fully succeeded in purchasing loyalty with a wage increase. Indeed most employers are quite unhappy to discover after a generous wage increase that employe discontent seems to be about as great as it ever was.

Wages are important, without question. The small plant which makes an effort to provide an opportunity for higher earnings to those employes who put forth extra effort is definitely moving in the right direction. Quite often small plants think this is impossible and that wage incentive methods must be left to larger organizations or to companies having repetitive production. However, careful study will frequently show how group bonus plans, profit sharing or savings sharing plans can be applied.

If a company fails to offer opportunity for added earnings in reward for additional effort, then it must inevitably accept a certain mediocrity in performance. Likewise it is likely to lose capable workers, leaving a level of mediocrity in the capabilities of employes who remain.

Of equal importance with the opportunity for high earnings is the opportunity for promotion. In a small

plant there are likely to be relatively few vacancies which could be considered as promotions. Because of this condition it is important that each plant develop material from the ranks so that when the occasional vacancy does occur, someone will be available and, if possible, a train of three or four promotions can ensue. There is nothing quite so devastating to the morale of capable employes as to see worthwhile vacancies filled from the outside.

It is desirable that there be some orderly schedule of hourly and weekly rates. It is not true that inequalities exist in large organizations only. In general there will be inequalities where more than one person does hiring and sometimes there are inequalities even if only one person is involved. Small plants are particularly prone to fall into the error of paying low rates in depression periods although being forced to pay higher rates at other times. In this way indefensible inequalities arise. Sometimes men doing similar work in different departments are being paid widely dissimilar rates. Not infrequently employes who have been aggressive in going after raises have gotten them whereas the less aggressive but frequently the more competent and more loyal, have been passed by.

In recent years methods of job evaluation have been developed to search out and to correct these inequalities and such job evaluation methods are applicable to small companies—let us say any company that has more than 30 distinct jobs is a logical candidate for such job evaluation effort.

Not infrequently poor morale is caused more by rate inequalities than by the level of the wage scale itself. We can say this another way. Many a company with a low wage scale compared with community rates has good employe attitudes toward the wage scale because there seems to be fairness in administering those rates; in contrast, many a company paying a high level of rates but with many inequalites finds morale at a low ebb.

Fringe Benefits

In considering compensation don't neglect the fringe benefits. Employes look with favor upon group insurance, accident and health insurance and hospitalization insurance, particularly if other members of the family can be included. Since the pension problem arises in all companies sooner or later it is highly desirable that while a plant is small it takes steps to fund a pension plan with reasonable monthly or annual payments rather than to await some future time when the working force will be much larger but the funds needed to handle pensioners will be many times greater. It is well to put aside modest sums during the working life of an employe so that these sums can be accumulating interest and piling up against the day when the employe should be retired. Insurance companies will lend the actuarial assistance needed for either insurance or pension costing.

One of the greatest blunders of American management—and many small company managements are just as guilty as the managements of large organizations—is to think that the terms "earnings" and "incentives" are synonymous. The use of wage incentive plans in industry has been so accepted by several generations of business executives that we tend to forget the all important non-financial incentives. The fact that financial incentives have failed to solve the problem of industrial unrest should be indicative in itself of the importance of treating employes as individuals and not merely as wage earners.

It has been our experience that those managements which have learned to administer participations and recognitions in abundance will inevitably reap a harvest of high morale. "Morale" someone has said, "does not well up from the bottom; rather does it trickle down from the top." If in the past most management policies *and practices* toward employes have been well conceived and well executed, the sum total effectiveness will be high morale.

There are many ways to accord recognition to an employe—ask his advice, quote him, assign him a difficult task, bring him in on discussions, notify him of future plans, praise him, put his name or photo in the plant paper, speak to him as you pass, put his name on bench or desk, ask him to break in a new employe, give him a higher title or a better job. And when you give him a raise, make a little fuss about it, so that he can tell his wife, not only about the money, but more important, these nice things the boss said!

Psychologists recognize what is called an effective wave of expansion. You reprimand the yard foreman who shouts at an employe who goes home to fight with his wife who spanks their child who in turn kicks the dog. What the dog does in this sequence has not yet been studied by the psychologists.

Or you praise the foreman who in turn helps an employe who bestows affection upon his tired wife who suggests the movies and gets a baby sitter for the youngster, who lets the dog curl up on the foot of his bed.

Each of your employes has an insatiable desire for recognition. Thwart it, and he will come to hate you; fan it and he will eat out of your hand.

Suggestion Box

You don't have to have a big organization in order to develop some kind of a suggestion system. You will do well to utilize the usual suggestion box. There are available some excellent standard boxes together with blanks, posters and integrated systems. Some companies have found that the suggestion system falls into disuse after a year or two but such disuse largely results from the failure on the part of management to revitalize the program in much the same way as it must revitalize the safety program.

Gripe sessions, discussion groups and many other types of conference with employes where employes feel free to offer their ideas provide good outlets not only for suggestions to improve production but also for grievances and complaints of many kinds.

The handling of grievances should be of special concern, be the company large or small. Since most grievances reach the supervisory level first it is important that first line supervisors have a clear understanding as to what procedure should be adopted. There is a tendency on the part of foremen to consider that grievances constitute a reflection on their ability to supervise. If foremen can be educated to the point that not only will they welcome grievances but they will actually invite them as a means of draining off complaints and emotional pressures which attend them, then the problem of grievances will be minimized.

Much the same can be said in handling criticisms of employes, where the "sandwich technique" should be used. For example, the maintenance mechanic has built up a stubborn habit of doing repair jobs exactly in the order they have been reported to him. Listen to a smart refinery superintendent handle this one:

SUPER—"Bill, I've been looking over your reports for the last few months" (bread.)

BILL—"Yeh?"

SUPER—"I sometimes wonder how you keep everybody happy." (butter.)

BILL—"I'm afraid I don't boss."

SUPER—"Well, anyway, I'm going to put more responsibility on you by asking you to set aside minor jobs, do the important jobs first." (there's the meat of it.)

BILL—"I used to do it that way, but every damned foreman thought his work should come first."

SUPER—"Well, Bill, I can see how you got sick of always being in the middle. But old hands around here like you and me understand these foremen." (butter.)

BILL—"Yeh, we sure do."

SUPER—"So you decide hereafter, will you, Bill. And if you get in a jam,

bring it to me, and I'll help you decide it." (bread.)

BILL—"Sure, boss."

Health and Safety

The maintenance of health and healthful conditions should be considered one aspect of the non-financial or intangible motivations. If employes have fears as to working conditions they are likely to substantiate their fears through accidents. Hence safety should be kept constantly before supervisors and employes but at the same time working conditions should be made as safe as feasible and wherever possible employes should be taken into this effort so that they will be convinced as to the fact. In developing safety programs it is necessary that they be revitalized from time to time—presented in new ways, new dramatizations developed, new safety education provided, new committees put to work. In most cases these activities will merely be repeating what has formerly been covered, but each time the effort should be in some new guise.

The fact that workers seem to accept working conditions does not necessarily mean that those working conditions are good. Employes will make marvelous adjustments to poor working conditions but the body sometimes pays the price of those adjustments. Typical would be working conditions where the lighting is bad or there is unnecessary noise. Lighting, ventilation, dust, fumes, wash rooms, toilets, lockers, drinking water, color of walls, painting of machinery and similar aspects of working conditions can be scrutinized by any management, be it of a large or a small company. Bad working conditions are two-edged—they may arouse discontent among employes and also decrease productivity.

In plants which are unionized, the proper handling of collective bargaining becomes important both as to financial benefits (wages and fringes) and non-financial motivations (recognitions and participations.)

Supervision

We have touched upon supervision from time to time as it is related to the other three factors—selection, training, and incentives. Obviously supervisors should be properly selected, well trained and themselves given tangible and intangible motivation to do their work. Obviously, too, they can become the vehicle for management to translate many of its policies and practices into action. Similarly they can be the means of communication between employes and management and management and employes.

But supervision in a larger sense starts with the president or with the plant manager. It includes the whole supervisory and executive level. As such it blankets all personnel efforts. What it does and says may make or break the techniques developed under the other three factors here covered.

It is important that lines of authority and responsibility be right. This phrase can be tossed off lightly, but experience in analyzing actualities in many plants reveals that what the organization chart indicates may not be the true status. Sometimes subordinates jump their immediate superiors because they have access to the boss; sometimes the boss goes right to the line worker without functioning through the proper supervisor. Not infrequently aggressive executives and foremen overstep their lines of authority and encroach upon the domain of others. Sometimes the original allocations of responsibility to executives have been wrong from the standpoint of function or from the standpoint of the capacity of the executive or supervisor to discharge the duties assigned to him. Hence a study every year or two of what actually goes on, not what the organization chart says it should be, may prove enlightening. So, too, such a study may indicate the causes of bottlenecks in production, of failures, of poor quality, of frictions, of high labor turnover or of discontent. Let us make no mistake about it, the supervisor, to the rank and file employe, is largely management. That supervisor holds in the palm of his hand the happiness or unhappiness of his subordinates for eight hours each day.

Based on attitude surveys which have been made throughout American industry, correlation studies show that the attitudes of employes toward immediate supervisors are more representative of employe attitudes toward the whole picture than any other single group of attitudes—in other words the supervisor is the company. This is another statement which has been tossed off casually for many years but too seldom has it been supported with statistical proof. Now we *know* it is true.

From the standpoint of top management of a small plant, planning and control are very essential. Where these are absent there is likely to be a cat and dog fight among various executives. Where planning and control are carefully conceived and executed, there is a quiet discipline which is exerted upon executives and supervisors all the time, a discipline which they come to respect and conform.

There are available excellent planning and control devices, many of them graphic but budgets, cost figures, charts and statistics are all part of the planning and control procedure of management.

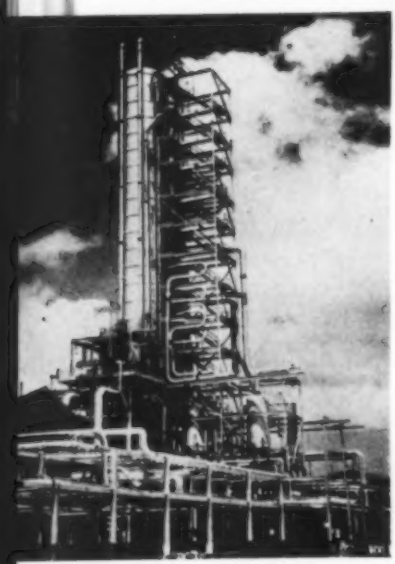
This article began with the observation that you don't have to be big in order to be good in industrial relations. True enough, you don't have to be big—but you surely do have to be active! And experience with companies large and small suggest that activity along the four avenues outlined is well designed to develop a high level personnel program.

Cardon, New Shell Refinery in Venezuela—a Panoramic View of the Distillation Facilities Photographed at Night.

Shell Cardon Refinery to Expand To 170,000 Barrels Daily

V. S. SWAMINATHAN, London

High Vacuum Unit at Cardon.



LEADING oil companies in Venezuela are giving practical support to the government policy of refining domestic crude oil locally by erecting and expanding such facilities. Late in 1951 the republic's refining capacity totalled 321,000 barrel's daily (including 74,500 barrels daily cracking capacity). Companies accounting for the major share of this capacity are Creole Petroleum Company, Mene Grande Oil Company, Shell Caribbean Petroleum Company, Sinclair Oil & Refining Company, and Venezuela Gulf Refining Company.

The capacity of Shell Cardon refinery, running early in 1951 at an annual rate of 3,500,000 tons, is being doubled this year. Work on the new extensions began during the first half of 1951, the additional facilities comprising a new distillation unit and modifications to the existing distillation unit. Also, a modern installation for the production of more than 100,000 tons of high quality lubricating oils is now in operation. Other features at Cardon include a comprehensive fresh water and electricity supply, up-to-date harbor facilities, and a township and residential area capable of accommodating 10,000 people.

The refinery, the industrial area and the residential sector occupy 3200 acres in the south-west corner of the Paraguana Peninsula. This once barren and wind-swept tract of land was chosen because it is the nearest deep sea water site to Maracaibo Lake oilfields. Moreover, the 50-foot cliffs forming the shoreline shelter the harbor from the north-east wind blowing across the peninsula with considerable force for most of the year.

On completion toward the end of 1952, the refinery's capacity will reach 170,000 barrels daily, and the entire project would have cost $200 million. Cardon will then be the biggest and most complete installation in Latin America, and one of the most modern in the world.

The Lummus Company designed both the crude units, high vacuum and gas separation plant, doctor treater, redistillation unit and lubricating oil plants. Universal Oil Products Company was responsible for the cracking units, the reforming plant and polymerization unit, while N. V. de Bataafsche Petroleum Maatschappij accounted for the acid treater, phosphoric treater and soda treater.

The first plant—crude unit No. 1—came on stream in February, 1949, less than four years from the date the first party set foot on the site. At the end of 1950 major units were completed and in operation as follows: a doctor treating plant and ethyl blending plant, a vacuum distillation plant, redistillation unit, cracked product separation pant, two thermal cracking units and a thermal reforming plant. At the time the project had already cost $140 million, and the consumption of more than 200,000 tons of steel.

Crude from Shell's oilfields in Western Venezuela is delivered by shallow-draft lake tankers. Work is in the final stages on a 30-inch pipe line connecting the oilfield terminus of Palmarejo, north of Lake Maracaibo, to the Cardon refinery. It is 163 miles long, and includes two submarine crossings, one at the Gulf of Coro and the other across the neck of Lake Maracaibo. The system is jointly owned by Shell Caribbean, The Texas Petroleum Company and Mene Grande Oil Companies, Shell's share being 89 percent.

In June 1951 foundations of a second crude distillation unit, with a capacity of 52,000 barrels daily, were laid. Coupled with modifications to step up the crude capacity of the first crude unit, and conversion of the redistillation plant to treat crude, the

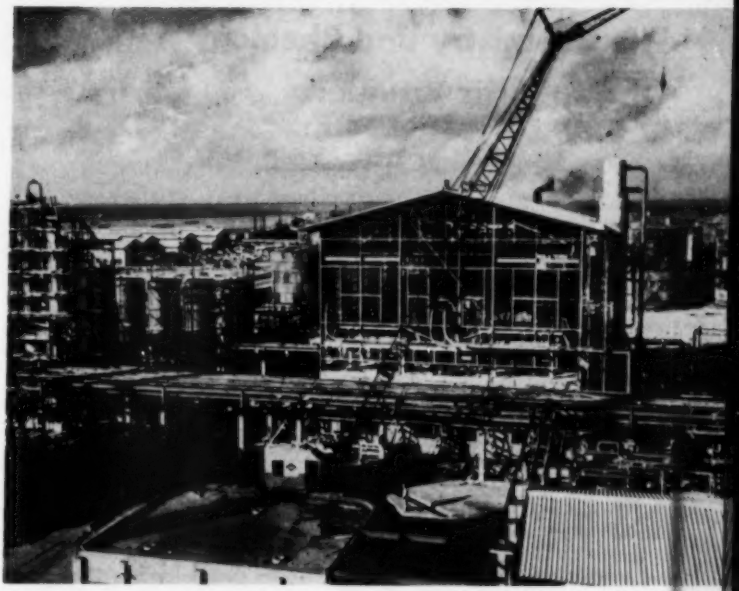
capacity of Cardon refinery will be raised to 170,000 barrels daily by the end of this year.

There will be a general balance of all products to meet world market demand with particular accent on fuel oil. Gross yield of products will be motor gasoline (regular and premium grades) 23 percent, kerosine 4 percent, gas oil-diesel fuel 12 percent, fuel oil 54 percent, fuel gas 4 percent, lubricating oils, bright stock, etc., 3 percent.

The crude distillation units are fed with "light" oils from La Paz and a certain proportion of heavier Lagulinnas for lubricating oil production. The two 12,500-barrel-daily cracking plants are designed to crack heavy crude (13° API) from the east coast of Lake Maracaibo (mainly from Bachaquero), while the 9000-barrel-daily reforming unit converts lighter oils and naphthas into gasoline of high octane number, to be employed as component of automotive gasoline. The gas separation plant recovers all cracked and reformed gases and light distillates by fractionation into gas, propane and butane fractions and cracked gasoline. The propane and butane fractions are fed to the phosphate treater for mercaptan removal and subsequent conversion by polymerization into a gasoline component. The treating plants deal with the purification and sweetening of other production from the tail gas and of the reformed gasoline.

The lubricating oil plant, which is extremely flexible in operation, consists of the following four units:—propane de-asphalting, furfural extraction, M.E.K. benzol de-waxing and clay contacting. The intake consists of Venezuelan reduced crude oils, both of the mixed base (paraffinic) and the naphthenic type. Lubricating oil distillates come from Lagunillas and Tia Juana crudes, and pass through furfural plant and clay contact unit, while those from La Paz crude entail de-waxing. The residue from La Paz crude processed in the lubricating oil plant must first be de-asphalted before it is converted into finished bright stock. Facilities for blending, packing and filling are available. The final lubricating oil products are of various grades including bright stock. They will serve a very wide range of purposes, including aviation, automotive and diesel engine lubrication.

At the south side of the refinery is the crude storage tank farm with a capacity of 2.2 million barrels. To the north there are 50 tanks with a combined capacity of 3 million barrels for the storage of products. The lube oil plant has a storage capacity of 750,000 barrels.



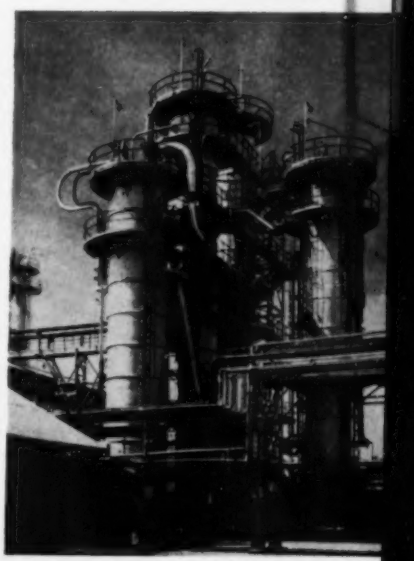
General View of the Methyl Ethyl Ketone De-Waxing Unit. Note overhead pipe tracks and filter building.

One of the most difficult problems at Cardon has been water supply, which, on the peninsula, is virtually non-existent. Until recently all fresh water for industrial and domestic purposes has had to be imported by tankers, while drinking water was obtained by sea water distillation. Now, an 80-mile pipe line brings fresh water for all purposes from springs and water wells at Siburua situated in the foothills near Coro on the mainland.

An outstanding feature at Carbon is the almost exclusive employment of electricity as motive power. Four 7500-kw. steam-driven turbo-generating sets and auxiliary equipment are in use at the 30,000-kw. power station to provide light and power for the refinery and the self-contained township erected nearby to accomodate the company's employes and their families. Each set is complete with exciter and a condensing plant and a pre-heating and evaporating equipment, and is suited for continuous operation in the salt-laden atmosphere of a tropical climate with an ambient temperature of 40° C. and a humidity of 90 percent at the same time. The turbines consist of horizontal single-cylinder impulse type (4-step), with a maximum continuous rating of 7500 kw. and a speed of 3600 rpm. The boilers can be fuelled by either fuel oil or natural refinery gas. Each boiler is capable of producing 45,000 Kg. per hour (normal rate) steam pressure; 40.5 Kg. per square centimeter at a temperature 425° C.

Harbor facilities comprise two large reinforced concrete jetties, each of which is 1500 feet long. Four large ocean tankers and four similar smaller vessels can be berthed simultaneously at Cardon.

Cracking Unit at Shell's Cardon Refinery.



The Chemistry and Rheology Of Asphaltic Bitumen

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Part II

Rheology and the Chemical Composition of Bitumens

SINCE significant physical changes may occur in the internal structure of a bitumen, it is clear that knowledge of its chemical constitution alone is not enough to determine all the properties of the bitumen. Nevertheless various attempts have been made to evaluate the role of the various components of asphalt from a rheological standpoint.

Zapata[97]* has shown that the viscosity of a bitumen is greatly influenced by the asphaltene content and to a lesser extent by the amount of resins. In general, the viscosity at a given temperature is approximately doubled by a 5 percent increase in asphaltenes with a constant resin content, and by a 10 percent increase in resin with a constant asphaltene content.

According to Saal and Koens[75] neither the maltenes nor the asphaltenes are plastic by themselves, but the degree of plasticity of an asphaltic bitumen containing a definite percentage of asphaltenes is governed primarily by the nature of the maltenes in the bitumens, the kind of asphaltenes being considered to be of secondary importance.

Maltenes are classified into three distinct types:

a) Those yielding non-plastic or practically non-plastic bitumens.
b) Those yielding asphaltic bitumens with a certain degree of plasticity.
c) Those yielding strongly plastic bitumens as obtained by vigorous air-blowing.

This view has in essence been confirmed by Mack,[43] who, in a series of experiments, separated the asphaltenes and maltenes from a series of asphaltic bitumens and mixed definite percentages of the asphaltenes of each of the bitumens in turn with the maltenes of the others. In the case of the maltenes from one bitumen, essentially true viscous liquids—or sol types of bitumen—were obtained with the asphaltenes of any of the bitumens, while with the maltenes from another, complex liquids were obtained with each of the asphaltenes in turn. Rheological methods were adopted to indicate the nature of the flow in each case.

The functions of the asphaltenes were also clarified by the same study. These constituents were shown to be responsible for the actual consistency of the asphalt, since an increase in the concentration of the asphaltenes in any of the systems invariably resulted in a marked increase in the viscosity, accompanied by more pronounced complex flow properties.

EXPERIMENTAL investigations by the author have led to new schemes for the rational classification of asphaltic bitumens based on rheological properties. Part I, presented in the February issue, outlined the methods used in the petroleum industry for the production of asphaltic bitumens, followed by a review of of the literature on fractional constitution, internal structure and colloidal nature. Part II discusses the effect of chemical composition on rheology of asphalts. The importance of temperature susceptibility is stressed and the problems of cracked bitumens and heterogeneity as related to the Oliensis test are described. Restrictions in certain bitumen specifications are criticized as being unjusitfied and the necessity for further research is emphasized.

Mack also showed that the types of maltenes which tend to give true liquids are aromatic in character and rich in sulfur. Those maltenes which have a low natural content of aromatics or in which aromatics or hydroaromatics have been eliminated by blowing are relatively poor solvents and possess poor peptising powers. In such cases, the asphaltenes are dispersed rather than dissolved in the maltenes and the individual molecules of asphaltenes are associated together to give fairly large particles, resulting in an asphalt with a gel type of structure. The decrease in peptisation of the asphaltenes leads to increased plasticity and elasticity.

From this work, Bingham[78] and Nellensteyn[55] have both concluded that the plastic properties of asphaltic bitumen are directly due to the asphaltenes, but this is not strictly in accord with the ideas of Saal and Koens mentioned earlier, since only the character of the maltenes can determine whether the asphaltenes are able to contribute plasticity at all on the bitumens. There is thus a definite distinction between the two views. It would be better to say that the asphaltenes are indirectly responsible for the property of plasticity in a bitumen only if they are dispersed in particular types of maltenes.

The reason why air-blown bitumens exhibit plasticity is easily explained on the foregoing basis, since the effect of air blowing is to transform the aromatic hydrocarbons of the maltene fraction into resins, which are finally converted into asphaltenes. The aliphatic hydrocarbon portion of the oily constituents on the other hand are not readily oxidized.

It follows too from the above arguments that the actual amount of asphaltenes in a bitumen cannot by itself be used for expressing the degree of deviation of the bitumen from Newtonian flow.

The question of the wax content has also aroused much interest in the past, and it is generally accepted[73, 45, 16, 17, 100, 70, 18] that an appreciable wax content in bitumen tends to lower the viscosity and may be deleterious to the performance of the bitumen in service.

In this respect it is worth mentioning the views of Endersby[23] who points out that wax is more resistant to oxidation than other components of bitumen, but probably produces a mechanical brittleness which is not related very closely to deterioration by weathering.

According to Clark[18] an excess of wax reduces the effective life span of an asphaltic product by lowering ductility and adhesion and greatly increasing susceptibility to temperature

* For references, please refer to Part I, published in Petroleum Refiner, February, 1952.

changes. After 15 years of close observation and research into the behavior of these products, he has tenatively established the amount of wax which is detrimental at about three per cent.

It is of importance to realize however that the properties of bitumens are not only affected by the actual content of wax but also by the form in which it exists.

Influence of Temperature on the Structure of Bitumens

As the temperature of a bitumen is raised, the asphaltenes tend to become more soluble in the continuous maltene phase, whilst the aliphatic portion of the maltenes becomes more soluble in the oily constituents. Consequently, there is a reduction in the radius of the protective medium around the asphaltenes, so that the oily constituents are able to flow more readily between the zones of influence surrounding the asphaltenes.

A gradual transition thus occurs in the nature of the flow exhibited by the system, any complex flow characteristics tending to become less pronounced and ultimately to disappear entirely if the temperature is increased sufficiently. This behavior may be attributed to a gradual transformation in the asphalt from a gel to a sol structure. At elevated temperatures the system may indeed exhibit truly viscous flow properties.

On the other hand, as the temperature is lowered, peptization of the asphaltenes is reduced. Consequently under such conditions, the asphaltene molecules tend to associate to form large particles, so that anomalous flow properties are more pronounced at reduced temperatures. Nevertheless, even at subzero temperatures, the system is usually stable from a colloidal standpoint, the asphaltenes remaining in a dispersed state owing to the protective action of the asphaltic resins.

It thus becomes clear that the physical condition of the bitumen at any temperature is primarily dependent on the degree of association of the asphaltenes, which is a function mainly of the chemical nature of the maltenes and also of the concentration of the asphaltenes. The chemical nature of the asphaltenes however plays a relatively minor part.

Practical Considerations

It is well known that when bitumen is subjected to changes in temperature, the material passes successively through a solid state at a temperature near the brittle point to become first a plastic solid, then a liquid plastic or semi-liquid, and finally a liquid at a temperature above the softening or melting point.

These steps are reversible and depend on the range and direction of the temperature change. For any particular bitumen the conversion from one state to another will take place over a definite temperature range, since there is no absolute line of demarcation between the successive states. In fact, even the brittle and softening points are not definite fixed values but, as a matter of convenience, have been standardized in different ways according to special arbitrary tests to give fixed points rather than indefinite wide ranges of temperature.

The condition of the bitumen at any moment is a matter of equilibrium between the processes of transformation in the direction solid-liquid on the one hand, and liquid-solid on the other. In practice, bitumens may at different times be subjected to a wide range of temperatures. In the first place, the temperature may be well over 400° F. for prolonged periods during storage and pumping operations at the refinery, whilst during application in road construction it may vary, according to circumstances, from about 250° F. to 350° F. Then the actual service temperatures on the road may range from below 32° F. in winter to 140° F. or higher by direct radiation from the sun in summer, particularly as the surfaces are black and heat absorbent.

A knowledge of the consistency or flow properties of bitumens over wide ranges of temperature is thus of fundamental importance in asphalt paving technology. For example, brittleness of a hard bitumen in service at low temperatures may lead to failures by breaking up of the bitumen—aggregate structure due to loss of the binding and protective properties. Again, at high temperatures, instability of road surfaces is often a direct consequence of a bitumen being too soft. This results in the formation of uneven surfaces, or, if excess bitumen has been used during construction, "bleeding" of the bitumen may occur, leading to slippery road surfaces.

The most useful way for determining the consistency of bituminous materials is by the measurement of viscosity at different temperatures. Such determinations are of course necessary at the refinery to control the uniformity of the product. Again, during mixing operations in road construction, viscosity is of vital importance, because it is upon this property that the distribution of the bitumen over the aggregate depends. In order to "wet" and cover the aggregate properly, a relatively low binder viscosity is normally required at the time of application. This is achieved in practice by preparing the heated premix at the appropriate temperature or by resorting to the use of bitumens cut-back with solvents which finally evaporate off the road surface. Bitumens possessing relatively low viscosity characteristics obviously permit the use of lower mixing temperatures than high viscosity materials and have the attendant advantage of less deterioration during mixing. The grading of the aggregate used is however an important factor, since coarse stones require a higher viscosity for adequate coating than fines.

In service, the actual viscosity of the bituminous binder largely determines the plasticity of the carpet, and in the case of surface dressings, the ability with which the stones tend to resist the displacing action of traffic.

Temperature Susceptibility of Bitumens

The term "temperature susceptibility," or "susceptibility" alone, as applied to asphaltic bitumens has been generally applied to express change in consistency with change in temperature. This property has received considerable attention from producers and consumers of bituminous materials as a means of distinguishing and characterizing products from different sources and methods of manufacture. It is also extremely useful in indicating the suitability of bitumens for specific purposes in which materials may be desired that show small or large changes in consistency with changes in temperature.

The practical aspect of temperature susceptibility has aroused much interest mainly because it supplies information relative to physical properties at both extremes of a temperature range. There is no doubt too that in practice the rate of change of consistency with temperature has a definite bearing upon the cost of a project besides affecting the quality of the work.

High temperature susceptibility is characteristic of severely cracked bitumens, and practical experience with material of this nature has in general shown unfavorable results and failures in service related to this property. For example, Rader[69] and Raschig and Doyle[71] have noted that this class of material tends to produce mixtures with aggregates which are least resistant to the formation of cracks in road surfaces exposed to low temperature.

On the other hand, Baskin, in discussing the paper of Traxler, et al.,[90] emphasizes that experience in two extreme territories—in tropical regions and in the sub-Arctic—has established

that the use of bitumen of low temperature susceptibility materially reduces and often eliminates breaking up of sheet asphalt pavements. In practice, the aim should be to utilize with the aggregate a bitumen which has perceptible pliability at low temperatures and yet is not so fluid at summer temperatures as to cause distortion.

Discussing the work of Lewis and Welborn,[42] Grant and Hoiberg have also commented on failures in service related directly to the use of highly susceptible bitumens. They have pointed out, however, that in some constructions such materials may withstand low temperature service most satisfactorily because an unyielding sub-grade may prevent flexing and cracking of the material.

As far as constitution is concerned, it is generally accepted that the susceptibility of a bitumen is greatly influenced by the asphaltene content[99,12] an increase in which is usually indicative of lowered susceptibility. If the oil phase is highly aromatic, the bitumen flow is generally viscous in character and the temperature susceptibility is high. As the content of aromatic oils decreases and paraffinic type oils predominate, the bitumen shows a lower temperature coefficient of change in consistency due to a decrease in peptization of the asphaltenes. In other words, the susceptibility of bitumens is a function of the change with temperature of the degree of dispersion of units formed by association. Bitumens which are highly plastic, therefore, have a low temperature susceptibility.

Broome[12] has shown that in general the presence of oxidized and polymerized constituents in bitumen has the effect of reducing susceptibility at normal atmospheric temperatures, but these compounds are frequently very brittle at low temperatures and more than ordinarily fluid above the softening point of the bitumen. It is also well-known that the addition of mineral matter to bitumen tends to reduce susceptibility.

Role of Bitumen as a Road Binder

While the ultimate behavior of a bituminous product in a road structure is undoubtedly associated with the nature of the aggregate, most investigators are of the opinion that it is essential to undertand the role of each of the components. According to Broome,[10] the success, or otherwise, of bituminous paving materials is probably more dependent on the chemical and physical characteristics of the actual bituminous portion than upon any other single factor. Kelley,[36] in a committee report on the characteristics of asphalts from more than 90 sources, points to failures or unsatisfactory results in asphaltic highway construction which are definitely attributable to the use of asphaltic material of poor quality. He shows that such cases are sufficiently prevalent to merit serious consideration.

It is evident, therefore, that special attention should be paid to the properties of the binder itself, because this is so much freer from the host of interfering factors that have steadily bogged down laboratory and large scale tests with mixtures of bitumen and aggregate. Some of these problems, for example, include the question of bitumen content and adhesion between the binder and aggregate. Additional considerations are variations in weather conditions; traffic intensity; nature, grading and absorptivity of the aggregate; mixing, placing and compaction effects; method of sealing; etc.

Thus it is not uncommon for engineers to obtain satisfactory results on one job, and unsatisfactory results on another, in which the identical materials have been used, apparently under the same specification of construction but in which some unforseen disturbing factor has taken part. This can readily be appreciated when it is realized that the possible ways in which road structures can fail are numerous.

Problem of Cracked Bitumens

Kelley[35] has outlined some details of badly needed research on asphaltic road materials, and is of the opinion that the complexity of the problem is far too vast and complicated to yield to individual and uncoordinated effort. Outstanding in this connection is the deficiency of authentic knowledge of quality requirements in relation to source of materials and refinery treatment. Experience has repeatedly proved that it is extremely hazardous to make dogmatic statements concerning the quality of bitumen which can be derived from a particular crude oil, merely on the basis of its geographical origin or under varying conditions of thermal treatment.

For example, one controversial question often raised, and still requiring to be settled, is the value in asphalt paving technology of cracked bitumens. In by far the majority of cases, the reports on the use of cracked materials have been decidedly adverse. These products tend to deteriorate rapidly, and become hard and lifeless with a complete lack of cementing properties. On the other hand, there is also conclusive evidence that not all cracked products are of this character. Some cracked asphalts have given excellent accounts of themselves in low-cost surfaces.[47] It appears that a great deal depends on the degree and extent of cracking, and, in the opinion of Hveem,[33] a moderate amount may even be beneficial. This is a typical example of products of one general class, which may be either good or poor, depending upon characteristics, which should be determined by actual test and not judged by preconceived ideas.

In the absence of suitable methods for measuring quality prior to use, there has been an unfortunate general tendency to place all cracked products in a single category, and to discriminate against the whole group. Research which can correct such a situation is of the utmost importance. In the interest of economy, too, it is desirable that a criterion of acceptability be established.

Heterogeneity and the Oliensis Spot Test

Oliensis[60] has devised a spot test to identify petroleum asphalts that have been subjected to more severe temperature conditions than are normal in regular steam-refining processes. The primary function of the test is to detect "cracked" asphalts.

A "homogeneous" or Oliensis negative asphalt has been conceived as one in which the internal phase relationship of all its many separate components is so stable that it can successfully resist the disruptive flocculating force introduced by diluting the mass with a fixed proportion of standard solvent naphtha.

Heterogeneity in asphalts is attributed to the presence of waxy, weathered, sludge or other bodies that happen to be poorly tolerated by or are incompatible with the rest of the mass of the asphalt. These bodies have for convenience been termed "carbenoids," and their presence disturbs the internal balance or "inter-compatibility" that exists in the normal asphalt and impairs its power to hold the components completely together when the surface tension of the whole mass is abruptly reduced by dilution with a solvent.

According to Oliensis, the test will not detect:

a) native asphalts from petroleum asphalts,
b) oxidized or blown asphalts from negative unblown asphalts, and
c) asphalts derived from certain geographical sources.

In addition,

d) The test may or may not detect blends of heterogeneous with homogeneous asphalts, depending on the proportion of the former and on the degree of heterogeneity.
e) The test does not apply to any asphalt containing finely divided non-bituminous matter insoluble in

xylene, as this masks the presence of "carbenoids" if they exist.

f) The test for obvious reasons cannot be applied direct to bituminous cut-backs or oils containing appreciable quantities of distillates, until all these have been carefully removed by an appropriate distillation process.

It is clear from the description of the test that it cannot in any sense be classed as a definite quality test, nor does it indicate homogeneity except under the specified test conditions. It gives no information as to whether the bitumen is homogenous when not in solution or when it is dissolved in any other solvent.

Considerable controversy has arisen as to the interpretation and value of the Oliensis test, but it has had the effect of arousing much interest in the importance of heterogeneity tests of asphalts.

Opinions on Oliensis

Carney and Grant,[15] Law,[40] and Skidmore[79] are strongly in favor of the test, while Hveem,[32] Krchma,[38] Batchelder and Wellman,[4] Zapata,[98] Benson,[8] Nevitt and van Doormaal[62] stress its limitations and point out that it is extremely difficult to classify bitumens as cracked or uncracked simply on the basis of the Oliensis test.

The original test method and a number of variations thereof have been studied by Oliensis himself, viz., xylene equivalent test,[61] negative period test,[62] hexane resistance test and gilsonite equivalent test.[63] According to Voskuil and Robu,[93] microscopic examinations of residues cracked under different conditions gave variable results; some straight-run residues were almost homogeneous but others contained many inhomogeneities in the form of sludge. The work of Lang and Thomas,[39] by microscopic examination of degree of coagulation in dilute naphthe solution, was not very informative; but with nitrobenzene as solvent, highly cracked asphalts—Oliensis positive—had highest particle count.

Contradictory data obtained by Lewis and Welborn[42] showed that the purpose of the test is defeated since the possible addition of homogeneous asphaltic minerals can mask the presence of heterogeneous bitumens. Winterkorn and Eckert[95] have extended the spot testing method to mixtures with partial solvents besides naphtha. Furfural, aniline, alkyl acetates, nitrobenzene and pyridine give positive spots in all cases whereas naphtha, ether and acetone give variable results. In a similar study, Benedict[5] points out the advantages of the use of 65 percent normal heptane and 35 percent xylene instead of naphtha.

According to Young,[17] Clark's[17] paper, a classification of road surfaces by the Texas Highway Department showed that the mileage of satisfactory, intermediate and poor surfaces over 2021 miles of bituminous courses one to five years old, was about the same whether positive or negative asphalts were used.

The foregoing discussion on heterogeneity in certain aphalts has been emphasized to show how unreliable this method of attack really is. There is no doubt that in general the term "cracked bitumens" has in the first instance not been properly understood by many investigators and has in fact often been misapplied. For this reason many reports on the value of cracked products have been conflicting, simply because the degree of cracking has not been specified and the term has been applied too loosely.

No really satisfactory method has as yet been demonstrated from a chemical point of view, which quantitatively indicates the degree of cracking.

The question which needs answering is not "Where did the material come from?" but "Is it any good for the job on hand?" It appears to the writer that much of the present controversy in connection with the Oliensis test could have been avoided if these two straight-forward questions had been borne in mind.

In reality the test is simply a form of solubility test which vaguely falls between the two extremes of total solubility as exhibited by carbon disulphide on the one hand, and total flocculation of asphaltenes by a partial solvent such as petroleum naphtha on the other. By careful control of test conditions two classes of asphaltic material may be separated, one in which no precipitation occurs, designated as negative, and the other in which some precipitation does occur, designated as positive.

The futility of pursuing this subject without regard to the physical characteristics of bitumen, as was done by Oliensis and by certain of his followers, was apparent to the present investigator at the outset, and the policy was accordingly adopted in his own experimental work of concentrating primarily on physical and flow properties of bitumen and classifying bitumens on the basis of the results obtained irrespective of the origin of the material and of its method of manufacture. Materials have unfortunately too often been condemned without a fair and unbiased trial merely on a cursory knowledge of its supposed history. Once a reasonable index of classification has been obtained for a bitumen on the basis of its physical properties, then is there time enough to trace its historical connection so as to aid where possible in the production of an improved material.

Bitumen Specifications

It has been generally accepted that the quality of any particular bitumen depends primarily on the nature of the crude oil from which it has been derived in conjunction with the methods adopted in refining. Moreover, by maintaining different plant conditions, a wide range of bitumens with differing properties, may be obtained from a single source. When cognizance is taken of the many diverse types of crude oils that are processed all over the world, it becomes clear that the variety of bitumens which may be encountered in practice is considerable.

While many changes in the quality of a bitumen can be made by the producer, the only control the consumer has over such changes is indirect, through the adoption of specifications. Present-day specifications, however, are so open that almost any bitumen can be used under different circumstances, because the development of tests to measure the quality of asphalts for road construction has not kept pace with changes in the source, manufacture and use of the material. Numerous special tests have as a result often to be specified. In many instances, these are not direct measures of quality, but serve rather to identify certain products which experience may have shown to give unsatisfactory performance.

Grant and Hoiberg[25] have pointed out that the selection of the proper specification tests can become even more complicated and misleading, since by skillful refinery manufacture similar physical properties may be obtained from asphalts of widely differing composition. As an example, they cite one particular case in which excellent paving qualities were displayed by a bitumen obtained from a certain crude, while a variation in the method of production resulted in a cheesy material of low adhesion properties and with very poor serviceability.

It is worthy of note that the Public Roads Administration of the United States has tried to circumvent fixed specifications by the following clause:

> "Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable under this specification."

Again at the proceedings of the Montana National Bituminous Conference in 1939, a suggestion was made by Campbell[14] that a statement should be appended to bitumen specifications

to the effect that borderline materials would definitely be rejected rather than allowed to become controversial. This argument was based on the grounds that there is no justification for permitting the use of doubtful materials.

Restrictive clauses such as those just cited are not to be commended. In common with users of other products, particularly in times of shortage, asphalt technologists should aim at finding out how to use available materials and not how to reject them.

Benedict, in a discussion on a paper by Clark[17] on the selection and evaluation of crude oil sources of asphaltic road materials, states that there is a legitimate objection to any method that attempts to evaluate raw materials in terms of service. He feels that the highway engineer is primarily interested in the quality of the product at his disposal. Specifications should be so drawn as to define the product properly at the time of receipt, and not after it has been in service for some time.

Report of Lewis and Welborn

In 1940, Lewis and Welborn[42] made a comprehensive survey of representative materials submitted by producers throughout the United States. The samples were all examined critically according to Federal, ASTM and other modified specifications to meet special conditions. Certain additional methods—not usually adopted as control tests—were also included in the investigations in the hope that further valuable information might be obtained.

The principal standard ASTM tests, reviewed by these investigators were as follows: Specific gravity, penetration, softening point, ductility, loss on heating, residue of specified penetration, Saybolt furol viscosity, float test, bitumen soluble in carbon disulfide, bitumen soluble in carbon tetrachloride, insolubles in 86° Bé naphtha, and sulfur.

Among the special tests examined were the much discussed Oliensis spot test and its successor, the xylene equivalent;[61, 62, 63, 64] the translucent film test of Benson;[6] the toughness test of Meyers;[49] and a series of temperature susceptibility factors, the most notable of which were the penetration index of Pfeiffer and van Doormaal,[67, 68] and the fluidity factor of Zapata.[97]

No definite information regarding the source of bitumen or method of refining could be deduced from the mass of data collected. It also became evident that even uniformity of supply from the same producers could not be controlled, nor were there any indications as to measures necessary to prevent deterioration during mixing, construction and service. In fact, no definite correlation between test data and service performance of the bitumens could be found to show that any of these tests individually evaluate quality or durability.

A large number of bitumens failed to pass many of the special test requirements, but gave relatively satisfactory service. For this reason the authors concluded that discriminatory tests should definitely be discouraged. It is significant that in the discussion on the report of Lewis and Welborn, Klinger refers to instances where failures have been recorded in practice despite satisfactory compliance with the special specifications.

Considerable criticism was levelled at the report at the time of its presentation on the old score that it advocated tests for the ingredients of a paving mixture instead of for the finished mixture itself. It is of course conceded that it would be highly desirable to evolve a suitable quality test for the finished mixture, particularly one so devised as to differentiate between satisfactory and unsatisfactory binders, but the futility of trying to determine differences in quality solely by individual empirical tests without a suitable correlation of the results has been amply demonstrated.

Necessity for Further Research

From the standpoint of quality, the chief requisites for a bituminous binder used in mixtures of road construction have been enunciated by Prevost Hubbard[30] as follows:

a) Ability to coat the individual particles of mineral aggregate, to adhere to them and to bind them together to such an extent as
   (i) to achieve thorough waterproofing of the structure, and
   (ii) to increase the inherent stability of the aggregate to the degree necessary to prevent displacement under traffic.
b) Ability to resist disintegration due to atmospheric conditions.

The requirements set out above should be satisfied without the loss of plastic properties, because the plasticity determines to a considerable extent the life and serviceability of the mixture.

It is well-known that the properties of asphaltic mixtures are affected to a greater or lesser degree by heating, mixing and placing. The question then arises as to what extent such changes may be permitted without appreciable damage to the quality of the finished product.

Closely allied to this problem is the resistance to weathering action, or durability displayed by bitumens. Little concerning this characteristic can be foretold from the physical tests generally found in present day specifications, in which painstaking consideration is given to the condition of binders at the time of use, but generally very little attention to the quality of the material remaining on the road after exposure to oxidation and other effects.

Other problems requiring further intensive study involve the interrelationship between bituminous binders and their associated aggregates; the mechanical stability of such mixtures under varying conditions of traffic and of temperature changes; the adhesion of bituminous films to aggregate particles and the resistance offered by the films to stripping from the aggregate in the presence of water.

Research accomplishments to date have however been largely the result of individual effort, and consequently, more or less disconnected. In the past, the tendency has been for the pure research chemist to entangle himself in a maze of data mainly of academic value, whereas the highway engineer has too often been concerned primarily only with immediate practical results. As a consequence of this general lack of cooperation, asphalt engineering has moved very slowly from rough—and incidentally very expensive—full scale experimentation to the adoption of certain empirical laboratory tests which are intended to give some foreknowledge of the behavior of road combinations. Greater coordination and more intensified research is essential before the subject of asphalt paving technology can pass from the realm of empirical study.

Such a state of affairs is likely to exist until much broader information is gathered relating the physical and chemical properties of bitumens to their service behavior and until impartial field observation and service records from a large variety of sources have been collated.

An attempt of this nature has been made by the present investigator, who, as a sequel to long and patient laboratory experimentation, has correlated certain rheological properties of diverse types of asphaltic bitumen, and, in the course of other publications offers for general adoption a number of alternative new schemes for their classification and evaluation.

End of Part II and series.

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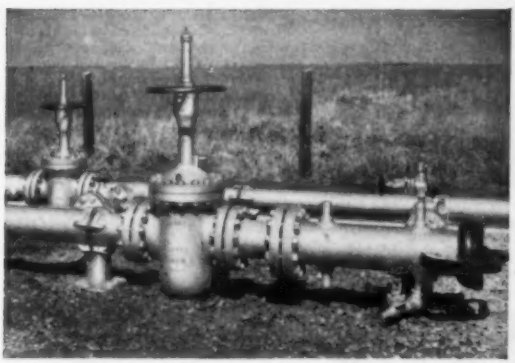

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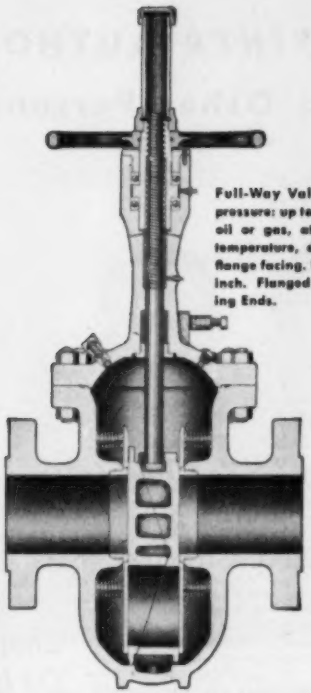

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the processing industry.

V. R. Ratzlow

A. A. Ruoho

Ruoho, Ratzlow Report On Natural Gasolines

A. A. Ruoho and V. R. Ratzlow, who co-authored "West Texas Natural Gasolines" on page 125, are both employed by the Phillips Petroleum Company at the Philtex experiment station at Phillips, Texas. Ruoho is manager of pilot plant operation for the chemical engineering division while Ratzlow serves as supervisor of the quality control section. In their spare time both men like to fish, square dance and go duck and quail hunting. Ruoho also admits he is a home gardener while Ratzlow includes bowling and home movies of the family among his spare time occupations. Incidentally, Ratzlow lists his family as a wife, two daughters, a dog, a turtle and three goldfish. Ruoho claims only a wife, a son, age 16, and a daughter, 10.

Joining Phillips in 1937, Ruoho has, over the past 15 years, held various supervisory positions within the research and chemical engineering divisions which required a well-rounded background of all research and engineering phases of Phillips' chemical program. Ratzlow came to the company in 1941 as a chemist and has been connected with their research and development program. He has been responsible for many analytical studies of major importance in connection with laboratory investigations and plant operations.

Forbes, Hobbies Lose Out To Business, Kids

M. C. Forbes, author of "Tough Water Control Problems Solved at Welder Plant" on page 142, claims that his hobbies were electronics and photography, and then pensively adds, "Before business and the kids took over." The kids, in his case being a pair of twins, James and John, born last year, an eight-year-old daughter, Metabeth, and another son, William Butler. Forbes' family is currently living in Houston where he is president and technical director of Aquatrol, Incorporated. Born in Hopkinsville, Ky., Forbes was educated in the Hopkinsville public schools, receiving his B.S. degree from the University of Kentucky in industrial chemistry in 1939 and his M.S. degree from Ohio State University in 1940. Then followed a seven-year hitch as a research chemist for Pan American Refining Corporation at Texas City, Texas, during which he married.

From 1947 through 1949, Forbes was employed as water engineer for the Celanese Corporation of America at Bishop, Texas. In 1949, he took over his present duties at Aquatrol. He is a member of ACS, Water Works Association, Natural Association, Corrosion Engineer, American Academy for the Advancement of Science and "a long time student of the stock market."

Chapin A Natural For Oil Industry Work

"I was literally born in the oil industry in 1920 on Shell's Norco refinery," says W. F. Chapin when he starts talking about himself and the oil business. When he was two years old, the author of "Modern and Unique Design Featured In Snyder Gasoline Plant" on page 119, moved to California, eventually settling at Long Beach and graduating from California Institute of Technology in 1941. Chapin then went to work at Permanente Metals Corporation's magnesium plant near Los Altos, Calif., doing plant technical service design, operation of new facilities and pilot plant and development work. A strong preference for the design phase led him into work for an engineering contractor and then to The Fluor Corporation where he has been since. Currently in Houston with Fluor's Midcontinent division, his work has been largely concerned with natural gasoline and petrochemical industries. He is a member of AIChE, a registered chemical engineer in California and the father of three boys.

Reeves Forbes Chapin

Robt. D. Beattie

D. F. Othmer

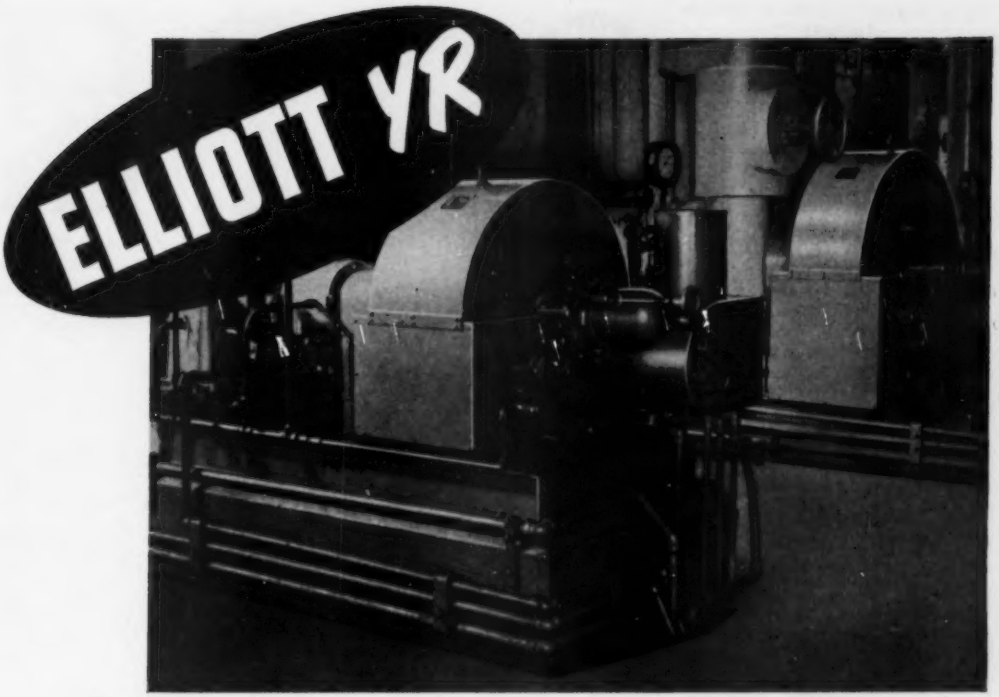
Professor, Engineer Combine Experience

A college professor, Dr. D. F. Othmer, and a process engineer, Robert D. Beattie, combined their knowledge and experience to produce "Correlating Heat Quantities of Lower Hydrocarbons" on page 129. Dr. Othmer, who married in 1950, served as development engineer for Eastman Kodak Company and Tennessee Eastman Corporation for several years before joining the faculty of Polytechnic Institute of Brooklyn in 1932. He was promoted to the position of Head of the Department of Chemical Engineering in 1937 and is a licensed chemical engineer in New York, New Jersey, Pennsylvania and Ohio, as well as a widely traveled lecturer.

Robert D. Beattie, process engineer at Godfrey L. Cabot, Inc., was born in New Haven, Conn., and received his education at Yale, Bucknell University and the Polytechnic Institute of Brooklyn. After stints at the Hanford Works and the Dewey & Almy Chemical Company in development work, he joined Cabot's research and development department. He is a member of Sigma Xi and the American Chemical Society.

Building Home Enough Activity for Reeves

Extra curricular activities of E. J. Reeves author of "Volumetric Contraction In Blending of Hydrocarbons," page 154, were listed as follows: "building a home—which is enough!" Reeves occasionally leaves his womenfolk, his wife and four year old daughter, long enough to indulge in his favorite recreation, hunting, however. Graduated from Rice Institute in 1943, he joined Magnolia as a process engineer, and his experience has been largely with waxes and lubricants. Presently supervisor of the Lubricating Oil and Wax section of the Process Control Laboratories, he is an active member of ACS, and has



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served on numerous committees of the Texas-Louisiana Gulf Section of that society. At one time Reeves served as "abstracter" for "Chemical Abstracts" and has published eight other technical articles. He is also the inventor of several U. S. registered patents.

Martin Is Old Hand At Eastern States

Back in the summer of 1937, H. M. Martin, author of "Eastern States' Platformer Completed In Record Time" on page 170, was working through the summer for Eastern States Petroleum Company when he made up his mind to become an engineer. Forthwith, he went off to Texas A. & M. where he combined practical training and academic knowledge by working through the summer for Eastern States and spending the fall and winter in college. The practice paid off in 1941 when he received his B.S. degree in mechanical engineering and joined Eastern States' permanent staff. With the exception of a hitch in the air force, Martin has been with Eastern in or around Houston ever since.

Henrichson Ridgway Benge

Henrichson, Maurer Cycling Plant Report

Authors W. T. Henrichson and J. J. Maurer, Jr., whose article "Taylor-Mayfair Cycling Plant Features New Instrumentation" appears on page 146, have been engaged in instrumentation work for quite a while. Henrichson, who has been with the Gasoline Plant Construction Corporation for the past four years doing instrument and electrical engineering for various plants, is a native Texan. Born in Cotulla in 1901, he graduated from the University of Texas with a degree in electrical engineering and promptly went to work for General Electric. Three years later, he joined American Cyanimid Company doing instrument and electrical engineering. Eleven years later, he was added to the staff of the Gasoline Construction Plant Corporation.

Coming to Mr. Maurer, we find we are somewhat in the dark on biographical details. The press of his duties at Taylor Refining Company and an out of town business trip prevented him from sending in biographical information and a photo.

T. H. Anderson

W. E. Colburn

R. A. Carpenter

F. C. Fowler

Braun Engineers Write Liquid Recovery Piece

Two C. F. Braun & Company engineers teamed up to produce "Liquid Recovery from Hydrocarbon Gases" found on page 137. **T. H. Anderson, Jr.,** graduated from MIT with a B.S. degree in 1932 and an M.S. degree in 1933, both in chemical engineering. Following graduation he joined the Standard Oil Company of Louisiana and entered the Baton Rouge refinery as a process-engineer. By 1936 he had transferred to the Standard Oil Company of California and was engaged five years at the Richmond refinery in maintenance and construction, and then another five years at the company's El Segundo refinery. Oranges lured Anderson to San Dimas for a short period but in 1947 he joined C. F. Braun & Company where he is now senior project engineer.

W. E. Colburn graduated from the Colorado School of Mines in 1942, having developed a keen interest in petroleum engineering as a student there. After a brief tour with The Texas Company, he joined Cal-Tech staff late in 1942 to assist in research on the Rocket Development project. Upon termination of this contract in 1945 he was transferred to the Bureau of Ordnance, but has been a member of the C. F. Braun & Company as a process engineer since 1947.

Dynamic Lecturer Wins Industrial Adherents

Purposeful and sure of his precepts, Eugene J. Benge affirmatively titled his article on page 177, "Certainly, Small Plants Need Industrial Relations Programs, Too!" Benge's demand as an industrial speaker has been growing rapidly, as has his activity as head of Benge Associates, Hu-Management Engineers of Chicago. In 1943 he started clinics for personnel managers, and added a clinic for sales managers in 1944, as a result of active interest during lecture tours under the auspices of Temple University, Philadelphia, the University of Pennsylvania, and Babson Institute.

Benge, who took his degree in public education, also studied at the U. S. Army psychological training school in 1918, and worked as a fellow in personnel research at Carnegie Tech at Pittsburgh. Following his academic study he became industrial relations manager for the Atlantic Refining Company, and has also served in that capacity for the American Oil Company. Since 1939 he has been president of his own company which conducts aptitude tests, morale surveys, job evaluation, merit rating and other probes into "Hu-management" problems.

Benge has written numerous guidance and text books and belongs to various societies. He and his wife are living in Asheville, N. C.

Article Is Phase One Of Research Program

The publication of "Ethylene By Steam Pyrolysis of Ethane" by Frank C. Fowler and Richard A. Carpenter on page 148 is a result of the first phase of a research program on the high temperature reactions of hydrocarbons conducted by the Midwest Research Institute in Kansas City. Fowler, who received his M.S. and Ph.D. degrees from the University of Michigan, joined Midwest Research Institute's staff in 1951 as a petroleum consultant. He had previously been senior process engineer in the chemical products department of the Phillips Petroleum Company at Bartlesville, Okla., and professor of chemical engineering at the University of Oklahoma. Twenty-five-year old Richard Carpenter was also added to Midwest's staff in 1951 as associate research chemist after two years at Shell Oil Company. Carpenter received his B.S. and M.A. degrees from the University of Missouri. He is a member of the American Chemical Society and Sigma Xi. Fowler is a registered professional engineer, a member of the ACS, AIChE and Sigma Xi.

Anniversary Appearance For Robert S. Ridgway

Robert S. Ridgway's appearance in this issue serves an anniversary function, since it was exactly one year ago when he last appeared in the pages of the REFINER, Part I of his article, "Compressor Cylinders For Flexible Operation," on page 166 is the feature of our Maintenance & Operation section this month. Background for that article lies in the work he has done in internal combustion and compressor engineering as a mechanical engineer at Standard Oil Company of California since 1928. Ridgway joined Standard of California in 1925 after receiving his degree at the California Institute of Technology and has since become more and more concerned with problems arising in gas engine and compressor operation, maintenance, design and installation. He is a member of CNGA and Tau Beta Pi.

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BOOKS of Current Interest

Review and Comment for the Process Man

Gas, Vapor Flammability

Limits Of Flammability Of Gases And Vapors, H. F. Coward and G. W. Jones, Bureau of Mines Bulletin 503, United States Government Printing Office, Washington, D. C., 40 cents.

This bulletin is the fourth edition of one of a series of publications issued as a result of cooperation between the Safety in Mines Research Board of Great Britain and the Bureau of Mines. A knowledge of the limits of flammability of methane and of the distillation products of coal in air and in partly vitiated atmosphere is of fundamental importance in the study and prevention of mine explosions. Likewise, a knowledge of the flammable limits of gasoline and benzol vapors, natural and manufactured gas, blast-furnace gas, hydrogen, acetylene, and many other gases is of equal importance in preventing gas explosions and fires in the metallurgical, petroleum, gas-manufacturing and related industries. The importance of such knowledge is shown by the increasingly frequent inquiries received by the Bureau of Mines for information on the limits of flammability of various gases and vapors when mixed with air or other atmosphere. Data on limits are widely scattered in the literature, and many of the figures seem contradictory. In this bulletin they have been arranged, coordinated and critically reviewed. A number of results that have not hitherto been published are included. There are now 155 substances in the summary of flammability limits in air and in oxygen as against 26 in the first edition.

Publications Reference

Technical Publications 1949, Edited by Arman E. Becker, Standard Oil Company and Affiliated Companies, 15 West 51st Street, New York.

A compilation of outstanding papers appearing in technical journals in 1949, this book presents 24 articles previously published by members of Standard Oil Company (New Jersey) and affiliated companies during 1949. Articles on geology and production, manufacturing, physical chemistry and analysis along with a list of other papers published in technical journals make up the complete volume.

Technical Information

Communication of Technical Information, Robert M. Dederich, Chemonomics, Inc., 400 Madison Avenue, New York. $5.

Executives handicapped by technical personnel who do not understand logically when and where information is needed, and professional people incapable of presenting their ideas intelligently to management, are given the fundamental principles for correcting such situations through study and understanding of fundamental principles of communication. The book is not an outline for report writing, nor does it concern itself with grammar, spelling and punctuation. The stress is on the thinking and logic which must underlie communication of technical information. Treatment deals with the written report, inter-organizational memos, progress statements and oral presentation.

Pollution Discussion

Air Pollution, Edited by Dr. Louis C. McCabe, Chief, Fuels and Explosives Division, Bureau of Mines, McGraw-Hill Book Company, 327 W. 41st Street, New York. $12.50.

The foundation for this volume was laid in December, 1949, when, at the request of President Truman, the U. S. Government's interdepartmental committee on Air Pollution was organized to sponsor a U. S. Technical conference on air pollution. The 97 chapters of the book reflect the thinking and experience of over 100 experts from industry, government, medicine, research and education. The properties of atmospheric contaminants is fully discussed along with equipment used in controlling air pollution. The book also takes up meteorological control techniques and air pollution legislation.

Fuels, Oils Analysis

Methods of Analysis of Fuels & Oils, J. R. Campbell and W. Gibb, The Chemical Publishing Company, Inc., 212 Fifth Avenue, New York, $4.

This book is a laboratory guide to the evaluation of gaseous, liquid and solid fuels with the theoretical foundation of the various test methods briefly discussed. Available analytical methods have been sifted by the authors, and the simplest standard procedures are included for the quantitative determination of the ingredients of all forms of fuel. The book, which contains fully illustrated instructions for assembling and using the test apparatus, includes tables on numerical data and equations for the calculation of results.

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Engineers Offer Youth Free Enterprise Guidance

A national organization of engineers is planned by the Engineers' Council for Professional Development to meet an emergency existing in U. S. high schools. At present, over-worked teachers give guidance to 200-300 students in addition to conducting classwork and other duties. The high school counseling program is suffering as a result, and the Engineers' Council has reported that these depression-born youngsters stand in tremendous need of guidance in free enterprise ideals.

Willis F. Thompson, chairman of the Guidance Committee, and vice-president and chief mechanical engineer of Westcott and Mapes, New Haven, Conn., has developed a plan for dividing the U. S. and Canada into regions headed by chairmen. From each regional chairman, interested engineers may secure descriptive folders of engineering careers and self-appraisal questionnaires. Volunteer engineers for this program will visit high schools in their vicinities to give down-to-earth talks on engineering careers.

ASTM Schedules McMaster For Marburg Lecture Session

Two significant lectures are in prospect for the Fiftieth Anniversary Meeting of the American Society for Testing Materials to be held in New York during the week of June 23, 1952.

Dr. R. C. McMaster, Battelle Memorial Institute, will deliver the 26th Edgar Marburg Lecture on the subject "Non-Destructive Testing." His 1950 ASTM technical paper, "A Basic Guide for Management's Choice of Non-Destructive Tests," was well received by the field.

The first H. W. Gillett Memorial Lecture is to be given by N. L. Mochel, manager, Metallurgical Engineering, Westinghouse Electric Corporation. Mochel has selected the subject, "Man, Metals and Power."

Nominations Requested For Ten Chemical Awards

Nominations have been requested by the secretary of the American Chemical Society for candidates to be considered for the 10 annual awards administered by the society. The awards will be presented at the organization's national meeting in Los Angeles in March, 1953. Most of the 10 awards demand that the nominee be under 36 years of age, a resident of the U. S. or Canada, and have achieved singular progress in the specific field represented. The awards are as follows:

American Chemical Society Award in Pure Chemistry, $1000 and diploma; Borden Award in the Chemistry of Milk, $1000 and gold medal; Eli Lilly and Company Award in Biological Chemistry, $1000 and gold medal; Fisher Award in Analytical Chemistry, $1000 and etching; Fritzsche Award for analysis, research

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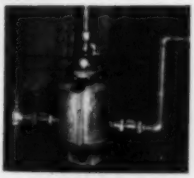

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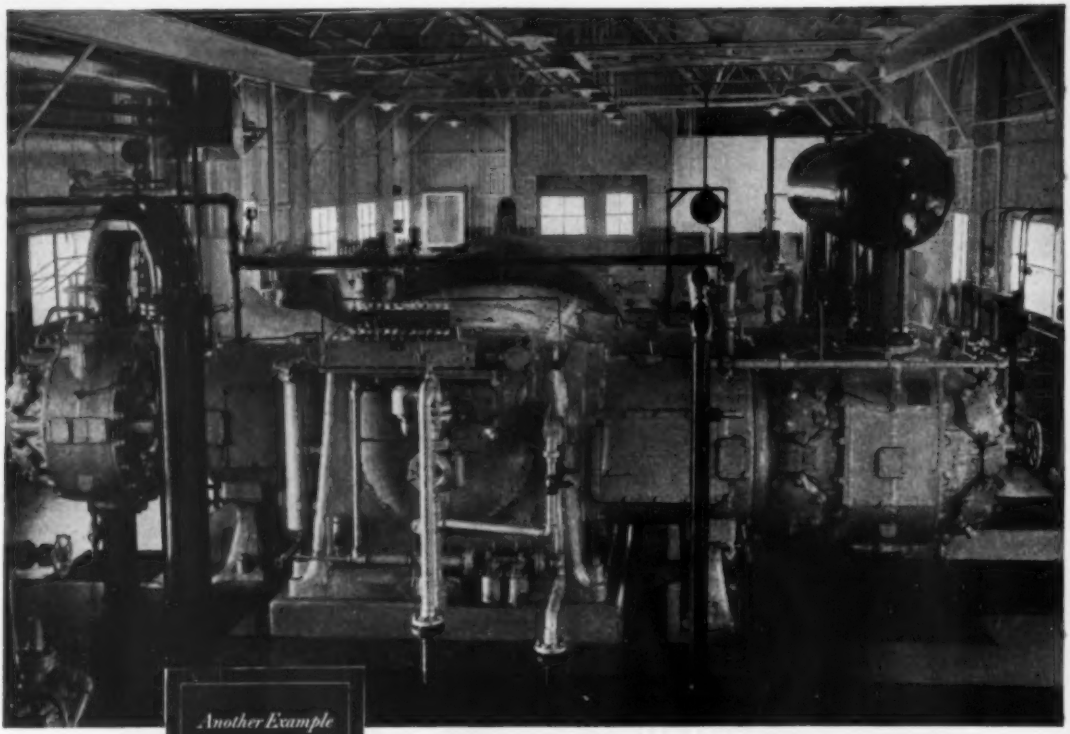

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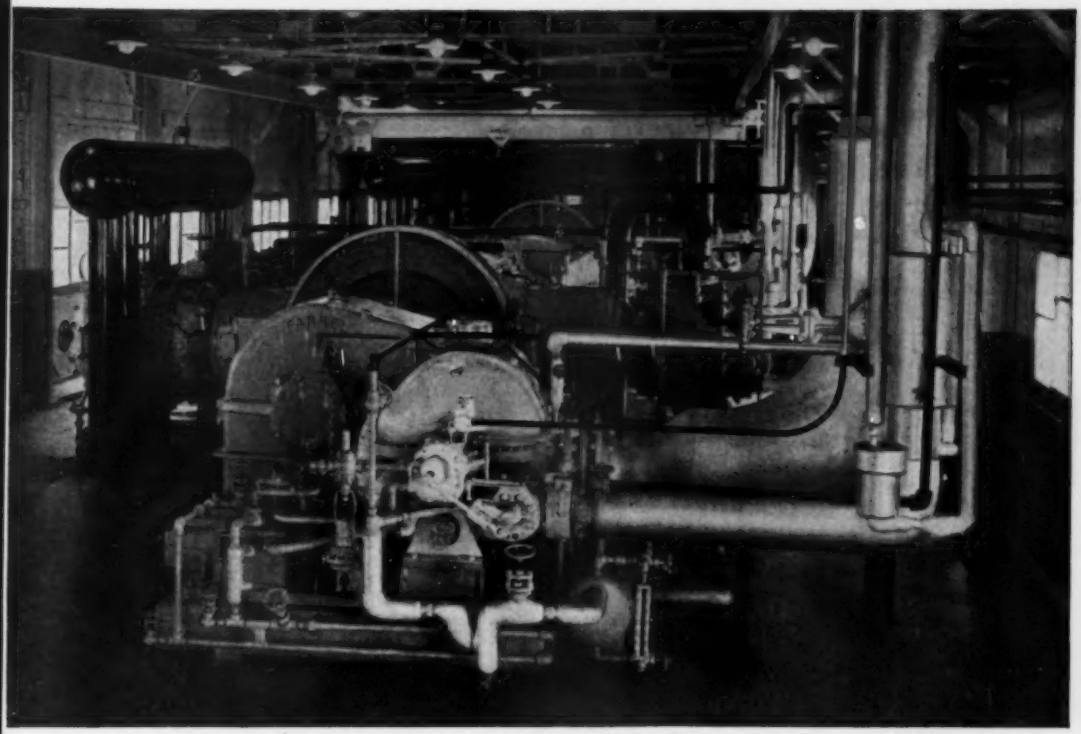

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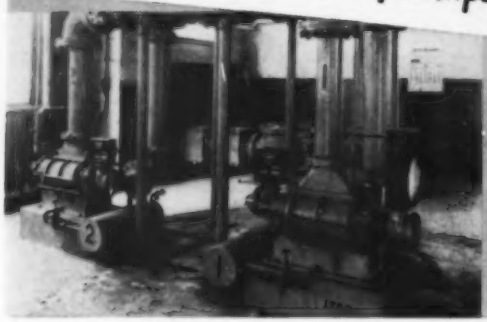

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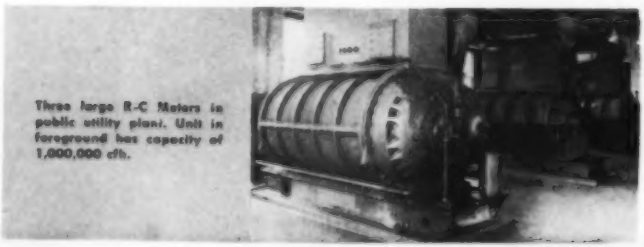

Three large R-C Meters in public utility plant. Unit in foreground has capacity of 1,000,000 cfh.

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Suggestions looking toward reader convenience and service are always in order. Address The Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

or applications of essential oils or related chemicals, $1000 and gold medal; Garvan Medal for women, gold medal; Ipatieff Prize for chemical experimental work by men or women of any nationality in the field of catalysis or high pressure, $3000, with an age limit of 40 years.

Paul-Lewis Laboratories Award, for non-commercial work in enzyme chemistry, $1000; Precision Scientific Award in petroleum chemistry, $1000; and the newest award, Scientific Apparatus Makers Award in chemical education for contributions to chemical education considered in its broadest meaning, $1000.

Nominations should include biographical sketch, list of nominee's publications and patents, specific identification of the work on which nomination is based, and evaluation and appraisal of the nominee's accomplishments.

Electron Microscopy Course To Be Offered At Cornell

The Summer Laboratory Course in Techniques and Applications of the Electron microscope will be given June 16-28 by the Laboratory of Electron Microscopy in the department of engineering physics at Cornell University. Designed for research workers who have recently entered the field of electron microscopy or who are now planning to undertake research problems involving applications of this instrument, the course is under the direction of Dr. Benjamin M. Siegel, with Dr. James Hillier, RCA laboratories, and Dr. C. E. Hall of M.I.T. as guest lecturers.

Penn State Scholarship Honors Oil Field Pioneer

A college scholarship fund established in honor of Edwin L. Drake, who drilled the world's first commercial oil well in 1859 near Titusville, Pa., has been set up at the Pennsylvania State College.

John P. Herrick of Olean, N. Y., oil man and author, provided securities having a market value of $27,500 to endow the perpetual scholarship fund.

Two scholarships to begin next fall will be given high school graduates aiming at an oil industry career in petroleum geology, mineralogy, or engineering but needing financial assistance to obtain the necessary technical knowledge and training.

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For copies of the catalogs and new equipment literature listed, use one of the convenient Reader Service Postcards on this page. Just circle the number on the card corresponding to the number of the item in which you are interested.

Gas Analyzers

Minneapolis-Honeywell Regulator Company has issued an instrumentation data sheet on the Davis indicating and recording flue gas analyzers. The unit utilizes a Davis thermal conductivity gas analyzer in combination with a Brown ElectroniK recorder.

Circle No. 1 on Postcard

Centrifugal Blowers

Construction features of Allis-Chalmers multi-stage Type V centrifugal blowers for equivalent air pressures above 6.5 psig. and inlet volumes above 1500 cfm., are described in a new bulletin released by Allis-Chalmers Manufacturing Company.

Circle No. 2 on Postcard

Diffraction & Spectrometers

North American Philips Company, Inc. has printed a catalog entitled "X-Ray Diffraction and Geiger-Counter X-Ray Spectrometric Equipment" which contains information on spectrometry and fluorescence analysis as well as the titlar subjects, and covers such components and accessories as tubes, rectifiers and cameras.

Circle No. 3 on Postcard

Light Safety Ladder

To users of ladders, concerned with safety and serviceability, Duraluminum Manufacturing Company has issued a folder illustrating the improved safety features of new Duraluminum life-time straight and extension ladders. Details of rung construction, siderails, safety locks and safety shoes are explained.

Circle No. 4 on Postcard

Fire Fighting Catalog

New portable fire fighting equipment is announced in Rockwood Sprinkler Company's latest catalog which includes technical data on products and chemicals. Among items described are the Fog-Foam nozzle with screen, the foam shaper, foam eductors, foam liquids, turret nozzles, waterfog nozzles, etc.

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New Catalogs AND EQUIPMENT LITERATURE

Use one of the free and convenient Reader Service Postcards on this page to request copies of the catalogs in which you are interested.

Built-in Truck Generator

A built-in generator has been developed for use with Towmotor electric pallet trucks, according to announcement by Towmotor Corporation. The built-in feature eliminates the need for conventional electric storage batteries and recharging, and provides constantly available power for 24 hour operation. It is known as "Towmotor Model W with Ready-Power".

Circle No. 6 on Postcard

Temperature Controls

Design, operating characteristics and installation of Thermoswitch temperature controls is described in a catalog published by Fenwal Incorporated. A special section concerns the selection and application of the Thermoswitch and discusses operating differential, sensitivity, temperature variation, lag and overshoot, among others.

Circle No. 7 on Postcard

Water-Softeners

Various methods of conditioning water and the purposes served by each are contained in a new Elgin Softener Corporation bulletin featuring an improved water softener of "double-check" design which gives up to 44 percent greater capacity and guards against costly loss of zeolite.

Circle No. 8 on Postcard

Flexible Metallic Packings

A bulletin describing R/M Flexible Metallic Packings has been issued by the Packing Division of Raybestos-Manhattan, Inc. The material includes description of "V" metal insert packings, metallic valve stem, plastic core metallic face, braided copper packings, etc.

Circle No. 9 on Postcard

Dust Respirator

Ten recently engineered advances are incorporated in a new dust respirator just announced by Mine Safety Appliances Company. Called the Dustfoe No. 55, it weighs under three pounds to provide maximum comfort to the user.

Circle No. 10 on Postcard

Explosion-Proof Motors

Construction details of Allis-Chalmers explosion-proof, fan-cooled and non-ventilated motors are described in a new bulletin released by the Allis-Chalmers Manufacturing Company.

Circle No. 11 on Postcard

Welding Fittings

Greater wall thickness structure of "Key-Kast" products is described in The Key Company bulletin on their new line of alloy steel welding fittings.

Circle No. 12 on Postcard

(More Literature Items on Pages 201, 203, 206, 208, 211.)

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A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	P2	Q2	R2	S2	T2	U2	V2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	P3	Q3	R3	S3	T3	U3	V3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	P4	Q4	R4	S4	T4	U4	V4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	P5	Q5	R5	S5	T5	U5	V5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	P6	Q6	R6	S6	T6	U6	V6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	P7	Q7	R7	S7	T7	U7	V7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	P8	Q8	R8	S8	T8	U8	V8
A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	P9	Q9	R9	S9	T9	U9	V9
A10	B10	C10	D10	E10	F10	G10	H10	J10	K10	L10	M10	N10	P10	Q10	R10	S10	T10	U10	V10

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NEW EQUIPMENT and Manufacturers' Literature

KEEP INFORMED by requesting additional information on new equipment and services described here. SAVE TIME by using the Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

Pipette Washer

Development of a new basket for the Fisher Scientific Company's Pipette Washer has been announced. Of stainless-steel construction, the basket supports pipettes for storing, washing, rinsing and transferring, and replaces the light metal bands formerly used for support. The basket is a slightly tapered cylinder, four-inches in diameter at the top and with a heavy mesh screen welded to the cylinder at the bottom. The washer has a glass cleaning chamber with an integral automatic syphon, and is provided with water by hose connected to the water tap.

Circle No. 13 on Postcard

Vinyl Primer

A new vinyl primer, Tygorust, specifically developed for use on rusted steel surfaces without the necessity for previous preparation, has been developed by the U. S. Stoneware Company. The coating is applied by brushing, spraying or dipping, and dries hard in a matter of minutes.

Circle No. 14 on Postcard

Materials Handling

How to handle materials advantageously is discussed in a bulletin offered by %Proportioneers, Inc.% Entitled "Streamlined Materials Handling in Continuous Production," it is the reprint of a talk by Rudy P. Lowe, delivered before the Akron chapter of the AIChE.

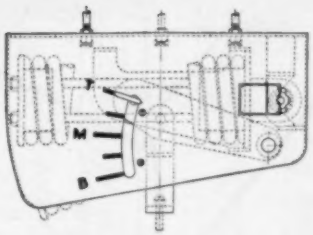
Circle No. 15 on Postcard

X-Ray Diffraction

"What Is X-Ray Diffraction" is published by North American Philips Company, Inc., to alert industry to the uses of this type of equipment for problems involving plastics, paints, fibers, cements, etc. It is claimed that this non-destructive analysis method speeds the defense program in identifying components to assure uniformity, in identification of unknowns, and identifying impurities.

Circle No. 16 on Postcard

Constant Support Hanger



A constant support type hanger of entirely new design has been announced by the Bergen Pipesupport Corporation. The Bergen hanger achieves true constant support for piping under all load and travel conditions, and is constructed to permit normal longitudinal as well as traverse movement without impairing efficiency. The hanger has a minimum of moving parts, uses only one compression spring, and needs no compensating device. Permanently lubricated needle bearings and self-oiling bushings minimize friction. The Bergen hanger is offered in 25 progressively graduated sizes ranging in travel from 2 to 12-inches and in load capacity from 50 to 8380 pounds. The units can be coupled or placed in multiples for increased capacity.

Circle No. 17 on Postcard

Instrument Mercury

The Bethlehem Apparatus Company, Inc., is processing mercury specifically for use in instruments requiring a high degree of accuracy. It is delivered in an unbreakable polyethylene bottle with a flexible dispensing tip.

Circle No. 18 on Postcard

Fire Detector

Fenwel Incorporated has announced new Detect-a-Fire units in both vertical and horizontal models. The new series incorporates the principle of rate compensation fire detection, which minimizes thermal lag and eliminates false alarm, insuring detection response as soon as the surrounding air temperature reaches the set point temperature of the device, regardless of the rate of air temperature rise. A bulletin is available.

Circle No. 19 on Postcard

Asbestos Packing

Teflon impregnated braided asbestos packing is manufactured by the Mechanical Packing Division of the Flexrock Company and offers a superior resiliency imparted to the Teflon by the integral asbestos fibres. This resiliency permits a tight, lasting seal at low gland pressure and solves the cold flow problem often found with solid Teflon packing. Furnished in continuous form, size 401 is suitable for packing a number of different stuffing boxes, and is serviceable at temperatures from minus 100°F. to 500°F.

Circle No. 20 on Postcard

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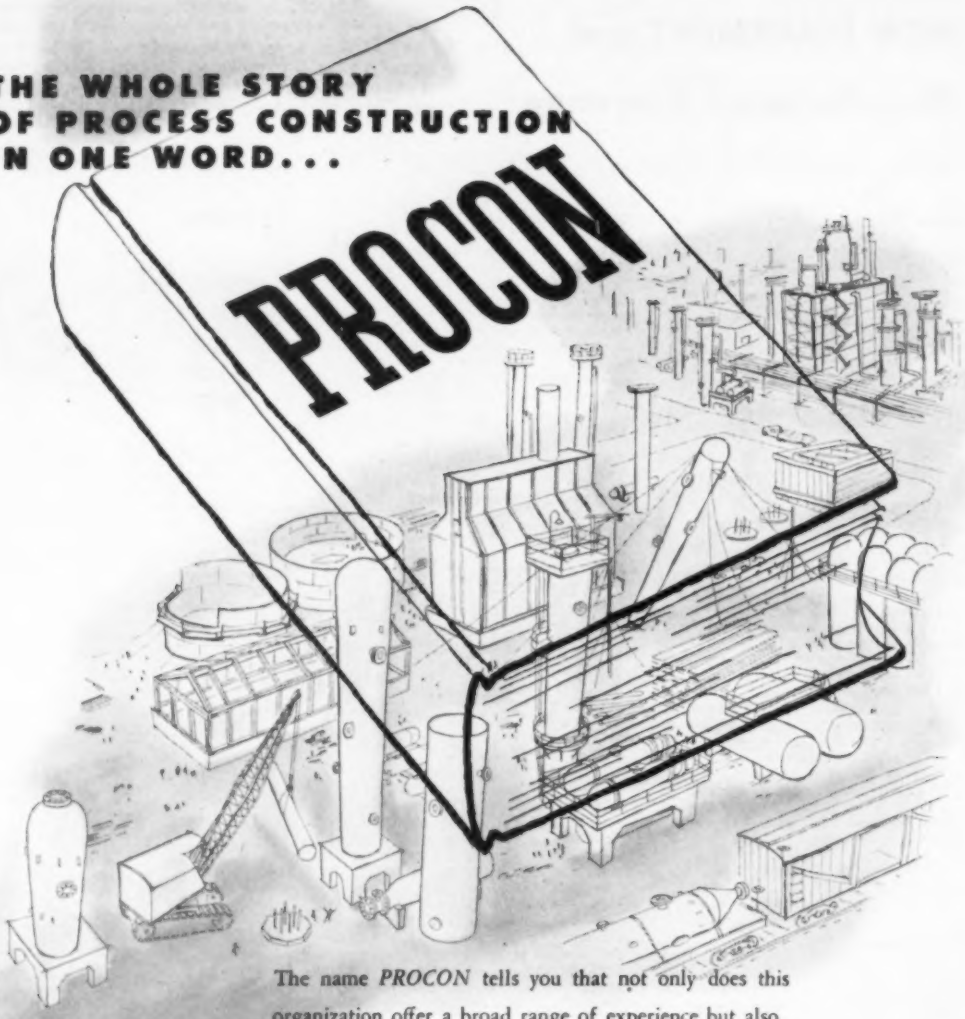

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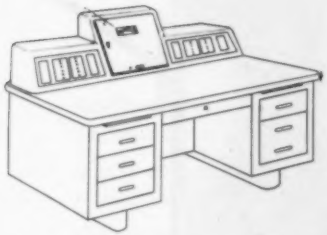
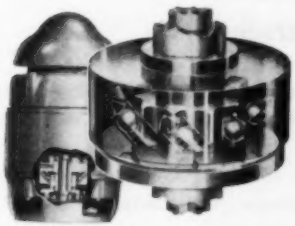
Temperature Control Desk



A newly designed console desk now makes it possible for a single operator to obtain plant temperature readings up to 96 processing points, according to Minneapolis-Honeywell Regulator Company who have engineered it. The 96 readings can be indicated in about as many seconds while the operator is seated at the desk, eliminating constant walking and logging from one end of a long panel board to another. The desk is 60 inches wide, has a steel surface with cutouts to accommodate an ElectroniK precision indicator and key switch banks or push-button assemblies.

Circle No. 21 on Postcard

Backstop for Vertical Motor



A new method of preventing reversal of U. S. vertical hollowshaft motors when electric motor current ceases and the vertical turbine water pump back-spins, has been developed by U. S. Electrical Motors, Inc. The manufacturer uses balls, the geometric form most ideally suited to provide quick engagement and maximum strength, in the construction design of the U. S. Ballomatic, a backstop it claims is quick-acting and dependable. The motor starting, throws the hardened steel balls out of engagement with the stationary member. When the motor stops, gravity pulls the balls down and one of them engages between the rotating member and the stationary ratchet, preventing reversal.

Circle No. 22 on Postcard

Regulator Design

Spence Engineering Company has offered a bulletin describing the design advantages of Spence regulators. The bulletin contains cutaway drawings to clarify written descriptions.

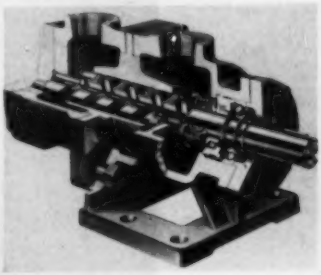
Circle No. 23 on Postcard

Electrode Support

Beckman Instruments, Inc., manufacturer of electrometric pH equipment, recently developed a battery-operated pH instrument incorporating a number of features suggesting greater convenience and adaptability in application. Known as the Beckman Model N pH Meter, it is light, compact and rugged, with an electrode support mounted on the side of the case so that it can be easily rotated to permit use in either a horizontal or vertical position. The electrodes plug-in to the side of the instrument case permitting quick interchangeability of electrodes from the extensive selection provided by Beckman. The electrodes cover almost the entire pH range from 0 to 14 and can be safely used at temperatures ranging from freezing to boiling.

Circle No. 24 on Postcard

Positive Displacement Pump



Designed to carry a wide variety of oil handling applications for pressures up to 275 psi., the new De Laval Steam Turbine Company's IMO A313B pump is said to save up to 40 percent in initial costs over other IMO models. The new rotary positive displacement pump has only three moving parts; it is reliable, quiet, pulsation-free, compact, and excellent for high-speed operation, reports De Laval. It can handle capacities to 80 gpm., pressures to 275 psi., and intermittent pressures up to 325 psi. A descriptive catalog is available.

Circle No. 26 on Postcard

Floor Reinforcement

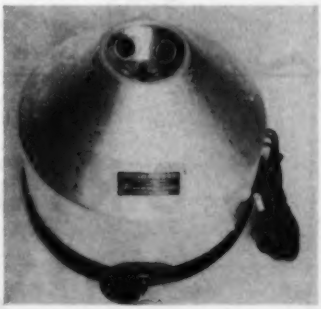
Although limited in supply, Acme Steel Company has announced availability of Floor Plate, an 11¾-inch square plate of .068-inch hot-rolled steel designed for the reinforcement and protection of concrete floor surfaces that are constantly subjected to heavy industrial loads and punishment. It can be installed as new floor surface or over old floors. Each plate contains 100 small rectangular holes and 100 barbed prongs which anchor the plate firmly to the concrete.

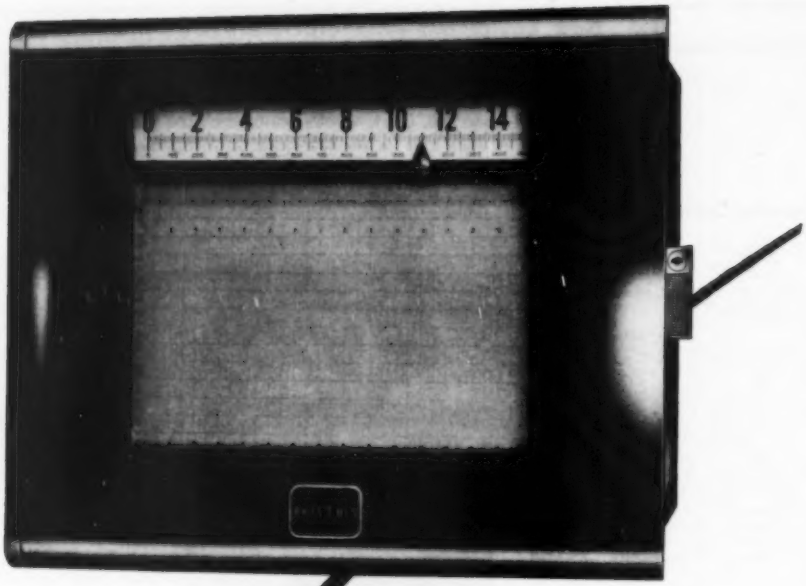
Circle No. 27 on Postcard

Angle Type Centrifuge

Introduced by the Scientific Glass Apparatus Company, Inc., the new low-priced Angle Head Centrifuge is recommended for applications where fast individual tests are required. All rotating parts are concealed by means of an aluminum guard, with a convenient opening at the top, which is fastened by screws to the base. Three large rubber suction feet provide additional safety and smooth operation. The balanced angle-type rotor is held on the sturdy shaft by a pin and setscrew. The centrifuge is controlled by a convenient "on" and "off" switch located in the base. The 115 volt, 60 cycle, AC motor is secured to a cast-iron base.

Circle No. 25 on Postcard





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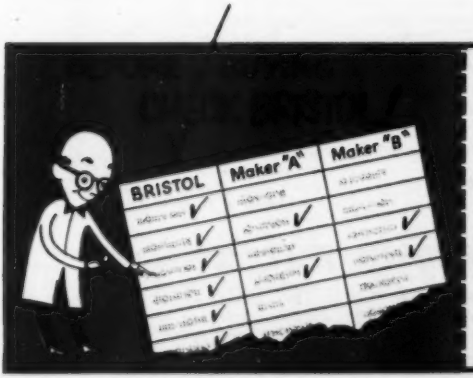

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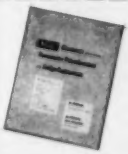

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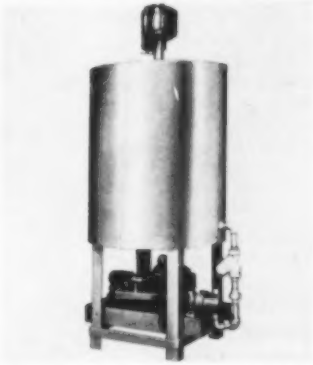
New Chemical Feed Unit



A new chemical feed packaged unit, which delivers liquids in desired amounts under pressure, has been announced by The Bird-Archer Company. This unit, which is suited for feeding boiler water treatment as well as delivering chemicals and other fluids for processing, is extra heavy Baco, offering high pressure controlled feed. The chemical reservoir tank is of welded steel construction, available in 50 or 100 gallon capacity. The chemical proportioning pump can be designed for various rates of feed at different pressures. A motor driven agitator assures completely mixed fluids at all times, and a stainless steel strainer is provided between the suction side of the pump and the tank.

Circle No. 28 on Postcard

Self-Leveling Burette

A new burette unit featuring a plastic reservoir which requires only a squeeze to fill an automatic self-leveling burette is announced by Hagan Corporation. The "Squeez-O-Matic" utilizes the plastic reservoir for simple easy operation as well as its high resistance to chemical attack. Provided with a special base which also provides a convenient and stable platform for beaker, flash or dish, the burette units are available in 25 ml. and 10 ml. sizes graduated to tenths of an ml.

Circle No. 29 on Postcard

Oil Leak Detector

A bulletin describing the new Paraprobe Fuel Oil Heater and Control has been issued by Davis Engineering Corporation, manufacturers of Heat Exchange Equipment. An electrical device designed to continuously monitor the condition of conductive liquids for the purpose of detecting undesirable contaminations and to give warnings to the operating personnel, the Paraprobe safety control can be used in either below-the-water-line oil heaters or with steam heaters.

Circle No. 30 on Postcard

Safety Storage Trays

Convenient, safe storage and handling of laboratory equipment is now offered by Laboratory Industries, Inc., through use of glassware trays which comes in two sizes. Both sizes have three sets of finger cutouts for easy removal of glassware. The entire tray is covered with Neoprene latex to provide a soft cushion for the containers; the Neoprene latex is also said to be very resistant to chemicals found in the laboratory. Separate catalogs provide further information on these trays, one 17½-inches long overall, and the other 20½-inches long, as well as the A. P. (all position) Support, for multiple glassware setups.

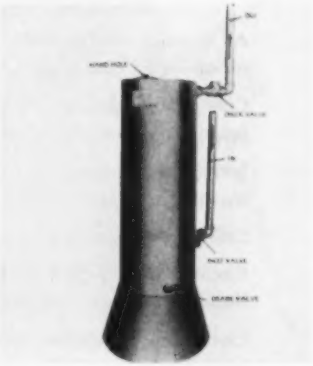
Circle No. 31 on Postcard

Manufacturers' Catalog

Chicago Metal Hose Corporation has published a catalog for product designer's use. It contains complete descriptions and specifications of products manufactured by Chicago Metal Hose for use by original equipment manufacturers.

Circle No. 32 on Postcard

Air Drier



Compressed air lines are kept clean and dry when Van Products Company's new Vi-Speed Air Drier is functioning. The air drier removes oil, dust, dirt, smoke, scale, and reduces humidity below the condensation point, as well as acting as a storage tank. Of simple, rugged construction which contains no moving parts, the unit is self-cleaning and self-regulating for easy maintenance. Model 25 delivers 25 cfm. and Model 200 delivers 200 cfm. of air at 100 psi. Dryolite, the filter material, is inexpensive and needs no processing.

Circle No. 33 on Postcard

Control Valve Assembly

Conoflow Corporation and Paul Valve Corporation have collaborated in the development of a complete line of throttling control valves, utilizing Conoflow Pneumatic Cylinder Operators and Paul Venturi Ball Valves. The Paul valve features a precision ground ball actuated by the Paul venturi ball principle. Since the Cono-cylinder operator utilizes a positioning mechanism as a component part, the assembly can be used in conjunction with standard pneumatic control instruments for automatic control, or with manual loading stations for remote manual positioning. The venturi passages and smooth surfaced ball provide a non-turbulent flow stream eliminating cavitation, as well as increasing capacity and improving controlability.

Circle No. 34 on Postcard

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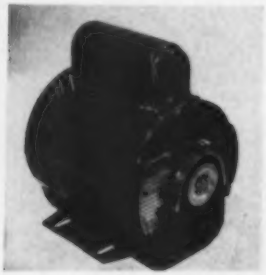
Fractional HP Motors



A new line of fractional hp. motors, designated "Form G," has been announced by the General Electric Company's Fractional Horsepower Motor department. According to GE engineers, the Form G motor weighs as much as 51 percent less per hp. than the models it replaces and is considerably smaller in size. The motors are available in open dripproof and totally enclosed fan-cooled models in Types K (polyphase), KC (capacitor start), KH (split phase) and KCP (permanent split capacitor). Engineered for dissipation of heat losses while retaining performance characteristics, the design incorporates a new insulation system consisting of special nylon material combined with Formex wire and Glyptal varnish.

Circle No. 35 on Postcard

Control Circuit Cable

Pneumatic and hydraulic control circuits are streamlined by use of Armortube Cable made by Bailey Meter Company. This flexible, protected multi-tube transmission line is made up of one-fourth inch O.D. aluminum or copper tubing gathered in a slow continuous spiral similar to the construction of rope. A tube bundle is first wrapped in water-repellent insulating tape, then encased in heavy rust-resistant, galvanized steel strip like that used for BX electrical cable. It is available in bundles of 4, 8, and 12 tubes and is capable of transmitting hydraulic control pressures as high as 3000 psig. and all ranges of pneumatic control pressures.

Circle No. 36 on Postcard

Galvanometers and Dynamometers

The complete line of standard galvanometers, dynamometers, d-c indicating amplifiers, and accessories for use in null-balance or calibrated deflection measurements is presented in the newly-revised, "Galvanometers and Dynamometers" recently published by the Leeds & Northrup Company.

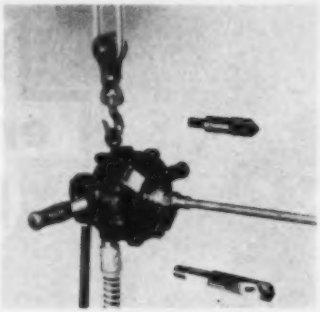
Circle No. 37 on Postcard

Controlling Pyrometers

A bulletin released by Asembly Products, Inc., describes the company's line of controlling pyrometers, known as Sim-ply-trol, and related equipment, available in temperature ranges from a minus 200° to plus 3000° F.

Circle No. 38 on Postcard

Condenser Cleaners



The Lagonda Division of Elliott Company has developed a new line of suspension-type condenser cleaners which incorporate improvements in design and control. Especially designed for cleaning small, straight tubes, the cleaners are efficient in removing both hard and soft deposits. The control valve is actuated by a "squeeze" trigger located at the base of one of the operating handles, and is convenient to the operator's right hand, but not in a position to be opened accidentally.

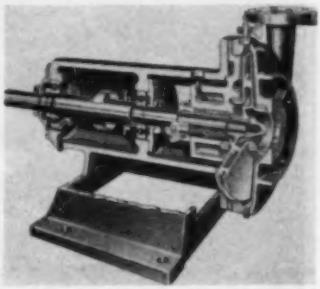
Circle No. 39 on Postcard

Electric Power Drives

Information on variable speed drives, geared motors and constant normal speed motors in drip-proof, splash-proof, totally enclosed and pipe ventilated designs is available in a new catalog published by Sterling Electric Motors, Inc.

Circle No. 40 on Postcard

Chemical Process Pump



This new chemical process pump by Peerless Pump Division of Food Machinery and Chemical Corporation has been designed for pumping moderate capacities against low, medium or high heads, and was especially created for use with corrosive and abrasive liquids containing solids in suspension up to five percent by volume. Designated Type DS, the pump is available in discharge sizes from 1/6-inch, with enclosed or open impeller design optional construction. Another optional feature is choice of grease-lubricated or oil-lubricated design. Grease lubrication is used for operation at temperatures up to 250° F., with oil lubrication utilized above that temperature. A new bulletin gives further particulars.

Circle No. 41 on Postcard

Oxygen Generator

Development of a semi-portable oxygen generator that will enable industrial users to produce their own high purity oxygen at great savings has been announced by Joy Manufacturing Company. Heart of the Joy oxygen generator is a series of automatic reversing heat exchangers which eliminate the expense of chemical purification of the air and contribute to high efficiency.

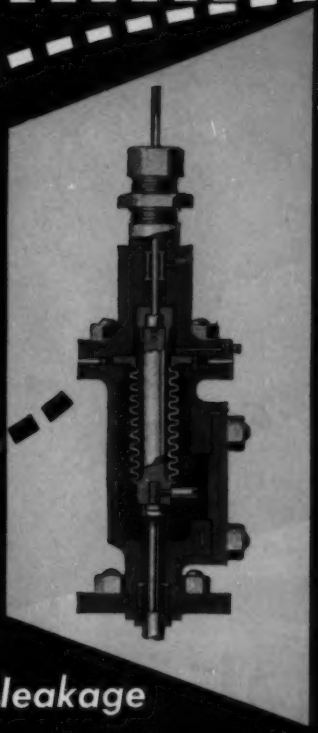
Circle No. 42 on Postcard

Protective Plastic Paint

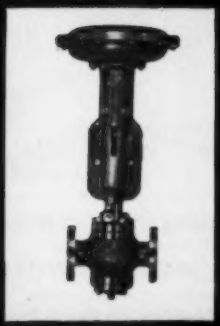
A new bulletin describing the characteristics, applications, and methods of use of Corrosite, protective plastic paint, is now available, The Corrosite Corporation has announced. The bulletin explains the Corrosite systems for painting metals, concrete, brick, stone, plaster and asbestos board.

Circle No. 43 on Postcard

POSITIVE PROTECTION . . .



prevents dangerous or costly leakage



The bellows seal of the Honeywell Series 700 Valve is a metal barrier which insures against loss of valuable or dangerous fluids . . . cannot buckle or twist . . . is precision-machined . . . takes pressures up to 600 pounds. The Honeywell Series 700 wide band proportional control valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2.

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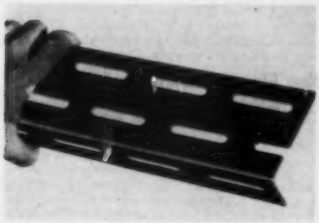
To obtain additional data use free Reader Service Postcard opposite page 200. Circle number on card corresponding to number listed at the end of each item on which more data or literature is wanted.

Galvanized Steel Angle



DexAngle, a 10-foot long, slotted-leg galvanized steel angle designed for all purpose industrial fabrication is marketed by Acme Steel Company, licensed to manufacture and distribute the product in the U. S. The lengthwise rows of slots in this "industrial erector set" unit permit rapid assembly by bolting of shelving, bins, scaffolding, etc. Diamond-shaped indentations spaced at 3-inch intervals along the length of the angle make measuring and cutting a simple operation.

Circle No. 44 on Postcard

Precision pH Meter

Precision built for reliable service and quick, accurate measurements of hydrogen-ion concentrations, the new Universal pH Meter was recently marketed by North American Philips Company. The instrument is for use with pH and rH work, for potentiometric titrations and for oxidation-reduction-potential investigations. It provides a measuring accuracy of 0.01 pH or 0.5 mv., a range of 0 -14.15 pH and 0- 1415 mv., combined with currentless measuring with no phenomena of polarization, and zero indication by cathode ray tube. It can be used with glass, quinhydrone, hydrogen and platina electrodes and is direct calibrated for the first three.

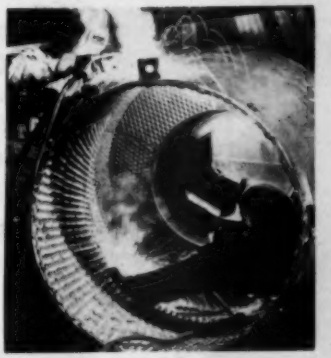
Circle No. 45 on Postcard

Enclosed Motors

Construction features and details of Allis-Chalmers Manufacturing Company's totally-enclosed, fan-cooled motors with tube-type, air-to-air heat exchangers in ratings from 40 hp. at 600 rpm. through 800 hp. at 3600 rpm. are described in a new bulletin released by the company.

Circle No. 46 on Postcard

Expanded Metal



A new kind of stretched steel lining designed to cut cat cracking costs by reducing deterioration of cast refractroy is being introduced by Wheeling Corrugating Company. When cast refractory is put into new cyclone catalyst separators, it will be applied over Wheeling Corrugating Company's expanded metal to hold it permanently in place. The wide-strand expanded metal is cut to shape and formed by cold rolling it to fit the concave inner surface of the cyclone separators. Arc welding attaches the expanded metal firmly in place, ready to receive the cast refractory after the cyclone units have been installed.

Circle No. 47 on Postcard

Flow Meters

Describing The Bristol Company's new "Series 500" line of Flow Meters, this new bulletin is devoted to instruments for recording, integrating, indicating, automatic controlling, and telemetering the flow of steam, water, air, gas, oil, solutions, and other fluids. Both mechanical and electric type flow meters are covered.

Circle No. 48 on Postcard

Giant-Sized Fog Nozzle

A new giant-size fog nozzle made especially to combat large fires in or out-of-doors, has been announced by Bete Fog Nozzle, Inc., and is called the Bete Giant Model 500 Fog Nozzle. The new nozzle delivers a 500-gallon-per-minute fog blanket with an effective reach of approximately 80 feet. Made with 2½-inch national standard thread connection, the new nozzle can be attached directly to a hose or turret gun having this thread. Made entirely of bronze, the new nozzle has external vanes for added strength in rough service.

Circle No. 49 on Postcard

Steam Jacketed Gear Pumps

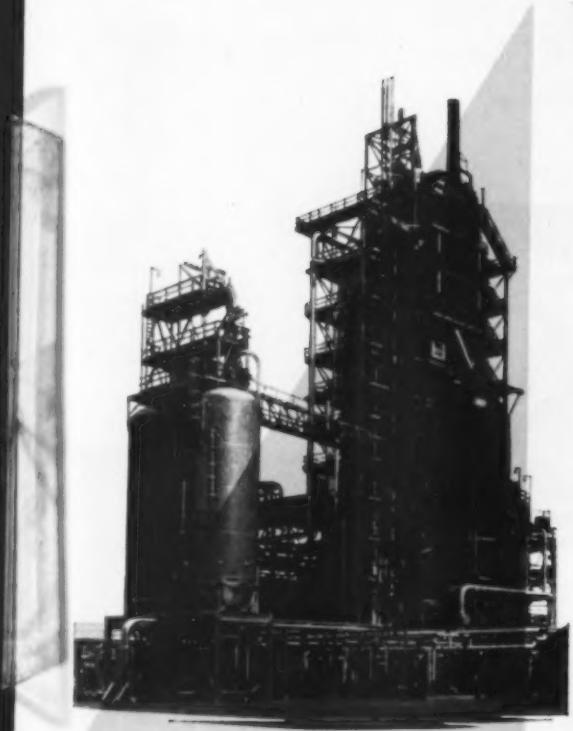
Many design features make the Steam Jacketed Herringbone Gear Pumps manufactured by Schutte and Koerting Company particularly well suited for handling viscous liquids at high temperatures. The steam jacket covers the internal parts, insuring even thermal distribution, and steam connections on the pump jacket are readily accessible to permit a variety of piping arrangements. Rigid housing construction eliminates any possibility of distortion due to pipe strain or misalignment, while straight bore housing eliminates shaft deflection and bearing overhang.

Circle No. 50 on Postcard

This Well Known Billings, Montana, Refinery

uses A. P. GREEN CASTABLE SK-7 and KS-4

in the Regenerator of its Cat Cracking Unit



SK-7 and KS-4 were used to form a compact monolithic lining in the regenerator of this cat cracking unit at Billings, Montana. In operation over two years . . . it is giving excellent service.

SK-7 and KS-4 offer 4 Outstanding Advantages . . .

1. Cuts construction time and labor costs.
2. Reduces rebound loss.
3. Is adaptable to a variety of installations.
4. Results in linings with balanced characteristics of poured castables.

A. P. Green SK-7 and KS-4 are two great new castable refractories, offering all the advantages of ordinary castables and, in addition, may be "gunned" in place by means of a cement gun. This fast, simple method of installation lowers construction and maintenance costs.

SK-7 and KS-4 were designed for use in combination. They form a composite monolithic lining and are the answer to the demands for castable refractory and insulating castable linings for unusually shaped equipment — the contour of which does not lend itself to the application of normal pouring castables.

A. P. Green REFRACTORY PRODUCTS

A. P. GREEN FIRE BRICK CO.
Mexico, Missouri, U. S. A.
In Canada
A. P. GREEN FIRE BRICK CO., LTD.
Toronto 15, Ontario
Distributors in the Principal Cities of the World

For detailed information concerning these castable refractories, write the Engineering Department of the A. P. Green Fire Brick Company . . . or call your local A. P. Green Distributor.

Catalogs AND EQUIPMENT *Literature* OFFERED IN THIS ISSUE'S ADVERTISEMENTS

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the identifying key number of each item in which you are interested. Postcards are opposite page 200.

CEMENT, CONCRETE AND CASTABLE REFRACTORY GUNS—Catalog. Air Placement Equipment Co. See page 270.
Circle A2 on postcard.

STEEL FLOOR PLATE—Bulletin S-52. Alan Wood Steel Co. See page 224.
Circle A6 on postcard.

TUBE TYPE MOTORS—Bulletin 51B7149. Allis-Chalmers Manufacturing Co. See page 31.
Circle A5 on postcard.

HEAT EXCHANGER TUBES—Booklet. Aluminum Company of America. See page 50.
Circle A7 on postcard.

STEAM TRAPS—Booklet. Armstrong Machine Works. See pages 60 and 61.
Circle A9 on postcard.

ELECTRONIC RESISTANCE THERMOMETERS—Bulletin 230-C. Bailey Meter Company. See page 70.
Circle B5 on postcard.

PIPE AND BOLT THREADER—Catalog. Beaver Pipe Tools. See page 265.
Circle B6 on postcard.

RELAY REGULATORS—Catalog Section 109. Black, Sivalls & Bryson, Inc. See page 36.
Circle B8 on postcard.

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS—Dynamaster Catalog. Bristol Co. See pages 204 and 205.
Circle C3 on postcard.

HEAT EXCHANGERS—Bulletin 481. The Brown Fintube Co. See page 82.
Circle C5 on postcard.

CENTRIFUGAL COMPRESSORS—Catalog. Carrier Corp. See page 68.
Circle C8 on postcard.

CHECK VALVES—Catalog 11. Catawissa Valve & Fittings Co. See page 246.
Circle C10 on postcard.

CHECK VALVES—Catalog 30. The Chapman Valve Mfg. Co. See page 24.
Circle D1 on postcard.

CONDENSER AND HEAT EXCHANGER TUBES—Booklet. Chase Brass & Copper Co. See page 118.
Circle D2 on postcard.

INSULATING JACKETING—Free Sample. Childers Manufacturing Co. See page 30.
Circle D5 on postcard.

POWER DRIVEN COMPRESSORS—Bulletin. The Cooper-Bessemer Corp. See pages 196 and 197.
Circle D10 on postcard.

PIPE LINE VALVES—Circular Ad-1864. Crane Company. See page 189.
Circle E2 on postcard.

REFINERY PUMPS—Bulletin. De Laval Steam Turbine Co. See page 241.
Circle E6 on postcard.

STAINLESS AND HIGH ALLOY EQUIPMENT—Catalog. Electric Steel Foundry. See page 223.
Circle F3 on postcard.

TURBINES—Bulletin H-16. Elliott Co. See page 191.
Circle F4 on postcard.

TUBE CLEANERS—Bulletin Y-29. Elliott Co. See page 251.
Circle F5 on postcard.

EXPANSION JOINTS—Design Guide. Flexonics Corp. See page 231.
Circle F9 on postcard.

AIR-COOLED HEAT EXCHANGERS—Bulletin FF-8501. The Fluor Corp. See page 18.
Circle F10 on postcard.

CONTROL VALVES—Bulletin 277-2. The Foxboro Co. See page 273.
Circle G2 on postcard.

WAX MOULDING MACHINE—Bulletin 51-2. J. W. Greer Co. See page 39.
Circle G10 on postcard.

COOLING TOWER FANS—Information. Hartzell Propeller Fan Co. See page 284.
Circle H4 on postcard.

BOILER FEED WATER TREATMENT—Bulletin 1855. Infilco Incorporated. See page 72.
Circle H6 on postcard.

MIXERS—Catalog. International Engineering, Inc. See page 244.
Circle H8 on postcard.

DUCTILE IRON—Publications List. The International Nickel Co. See page 9.
Circle H9 on postcard.

HEATED GAGES—Information. Jerguson Gage & Valve Co. See page 274.
Circle J1 on postcard.

EMERGENCY RELIEF VENTS—Catalog. The Johnston & Jennings Co. See page 114.
Circle J3 on postcard.

HEAT INSULATION—Book. Kaylo Division. See page 218.
Circle J4 on postcard.

INERT GAS GENERATORS—Bulletin 1-10. The C. M. Kemp Mfg. Co. See page 230.
Circle J7 on postcard.

TWIN SEAL VALVES—Bulletin. Kerotest Manufacturing Co. See page 238.
Circle J8 on postcard.

FRACTIONATING TRAYS—Brochure 629. The Koch Engineering Co. See page 229.
Circle J10 on postcard.

WATER WELL INSTALLATION—Catalogs. Layne & Bowler, Inc. See page 267.
Circle K1 on postcard.

PH INDICATOR—Folder EM9-96(1). Leeds & Northrup Co. See page 8.
Circle K2 on postcard.

CALIBRATING TANKS—Bulletin CT-101. Warner Lewin Co. See page 254.
Circle K3 on postcard.

TEMPERATURE MEASURING INSTRUMENTS—Catalog. Manning, Maxwell & Moore, Inc. See page 32.
Circle K8 on postcard.

MIST ELIMINATORS—Brochure. Metal Textile Corp. See page 260.
Circle L5 on postcard.

CONTROL VALVES—Bulletin 700-2. Minneapolis-Honeywell Regulator Co. See page 209.
Circle L7 on postcard.

MIXERS—Literature. Mixing Equipment Co. See page 78.
Circle L8 on postcard.

STEAM TURBINES—Bulletin T-122. Murray Iron Works Co. See page 234.
Circle L9 on postcard.

STEAM TRAPS—Bulletin 152. W. H. Nicholson & Co. See page 266.
Circle M6 on postcard.

MAINTENANCE CLEANING—Booklet F7629. Oakite Products, Inc. See page 261.
Circle M8 on postcard.

COMPRESSOR UNITS—Booklet 17-51. Oil Well Supply Division. See page 92.
Circle M10 on postcard.

PROCESS AND BOOSTING PUMPS—Bulletins. Peerless Pump Division. See page 15.
Circle N4 on postcard.

CYCLING AND SUMP PUMPS AND EJECTORS—Bulletins. Penberthy Injector Co. See page 195.
Circle N5 on postcard.

SPIRAL REVEL COOLING TOWER—Bulletin CT-51. Philadelphia Gear Works, Inc. See page 38.
Circle N9 on postcard.

BUBBLE CAPS—PSC Bulletin 21. The Pressed Steel Co. See page 89.
Circle P4 on postcard.

SCIENTIFIC LABORATORY EQUIPMENT—Bulletin 50. Refinery Supply Co. See page 264.
Circle P8 on postcard.

BALL VALVES—Bulletin V-4. Rockwood Sprinkler Co. See page 58.
Circle Q7 on postcard.

DISPLACEMENT METERS—Bulletin 40-B-14. Roots-Connersville Blower Corp. See page 198.
Circle Q8 on postcard.

CONDENSER TUBES—Booklet. Scoville Manufacturing Co. See page 27.
Circle Q9 on postcard.

LIQUID LEVEL ALARM SWITCH—Data. Shand & Jurs Co. See page 34.
Circle R1 on postcard.

PUMP VALVES—Catalog. Sims Pump Valve Co. See pages 276 and 277.
Circle R4 and R5 on postcard.

INVENTORS BOOKLET—Sinclair Research Laboratories, Inc. See pages 108 and 109.
Circle R6 on postcard.

TRANSET CONTROL SYSTEM—Bulletin 98097. Taylor Instrument Companies. See pages 84 and 85.
Circle S2 on postcard.

STEAM TURBINES—Booklet S-116. The Terry Steam Turbine Co. See page 41.
Circle S4 on postcard.

PRIMERS—Catalog 50. Tnemec Company. See ad opposite page 72.
Circle S8 on postcard.

PIPE INSULATION—Bulletin 76-109. Union Asbestos & Rubber Co. See page 40.
Circle S10 on postcard.

PACKING MATERIAL—Catalog. United States Gasket Co. See page 220.
Circle T1 on postcard.

ALUMINUM SCAFFOLDS—Circular. Up-Right Scaffolds. See page 55.
Circle T3 on postcard.

SCRAPED SURFACE EXCHANGERS—Bulletin PE-1. Henry Vogt Machine Co. See page 10.
Circle T6 on postcard.

IRON BODY GATE VALVES—Bulletin 106. Walworth Company. See page 23.
Circle T9 on postcard.

STEAM TURBINES—Bulletins. Worthington Pump & Machinery Corp. See page 7.
Circle U7 on postcard.

EXPANSION JOINTS—Bulletins. Zallea Brothers. See page 25.
Circle U10 on postcard.

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Other construction items and box-score tabulation page 93.

Leonard Refineries Expand Michigan Plant Capacity

Expansion field work is proceeding at Leonard Refineries in Alma, Mich., on extensive additions to increase plant capacity. The work is being done by Catalytic Construction Company and includes installation of a new synthetic crude tower plus additions and a revamp of the gas plant. The new construction will make it possible for Leonard to process 7000 barrels per day of gas oil in its catalytic cracking unit which originally had a rated charge capacity of 3000 barrels. Catalytic has engineered the current revamp and should complete field work on this operation in August.

Freeport Sulphur Plans $20 Million Program in 1952

Freeport Sulphur Company, oldest sulfur producing firm in the United States has announced it was spending $20 million on new projects to increase the supply of defense-essential sulfur. The announcement came with the company's 39 annual report which pointed up some significant developments within the company during the past year. Chief among these were the acquisition of new sulfur reserves, development in the Louisiana marshes of new brimstone mines and a production record which approximated the record output of 1950.

Magnolia's Gasoline Plant At Midland Near Completion

One of the first natural gasoline plants in Midland, Texas, being built by Magnolia Petroleum Company is nearing completion. Company officials hope the gas gathering and compressor station phase of the plant will be in operation early in the second quarter of the year. When completed the plant's initial engine-compressor installations will have a daily capacity of 30 MMcf of casinghead gas, but by the end of the year the capacity is expected to increase to 60 MMcf per day, the presently planned processing capacity of the plant.

McBride Company Expands, Modernizes Texas Plant

The McBride Refining Company is in the process of modernizing and expanding its 3500-barrel-daily refinery at Edinburgh, Texas, and will add a catalytic reforming unit with an 800 barrel per day capacity. Both projects are now under construction with completion expected on the reforming unit by July 1 this year.

Shell's New Catalytic Unit In England Now Operating

A new catalytic cracking unit at Shell Oil Company's Stanlow refinery in Cheshire, England, is now in commercial production at a rate of over 21,000 barrels per day. Built at a cost of $22.4 million, its completion marks the final stage in Shell's $84 million postwar refinery expansion program in Britain.

Why Good Pipe Fitters Choose

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No. 4P, 2½" to 4" pipe

Extra easy to carry and put on pipe

★ Balanced loop handles—easy to swing 4P where you want it.

★ Mistake-proof workholder sets to size *before* put on pipe—only one set screw.

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★ 4 sets of 5 high-speed steel dies for 2½", 3", 3½", 4" pipe. Ratchet handle; RIDGID Universal Drive Shaft available. Also special 4P for conduit.

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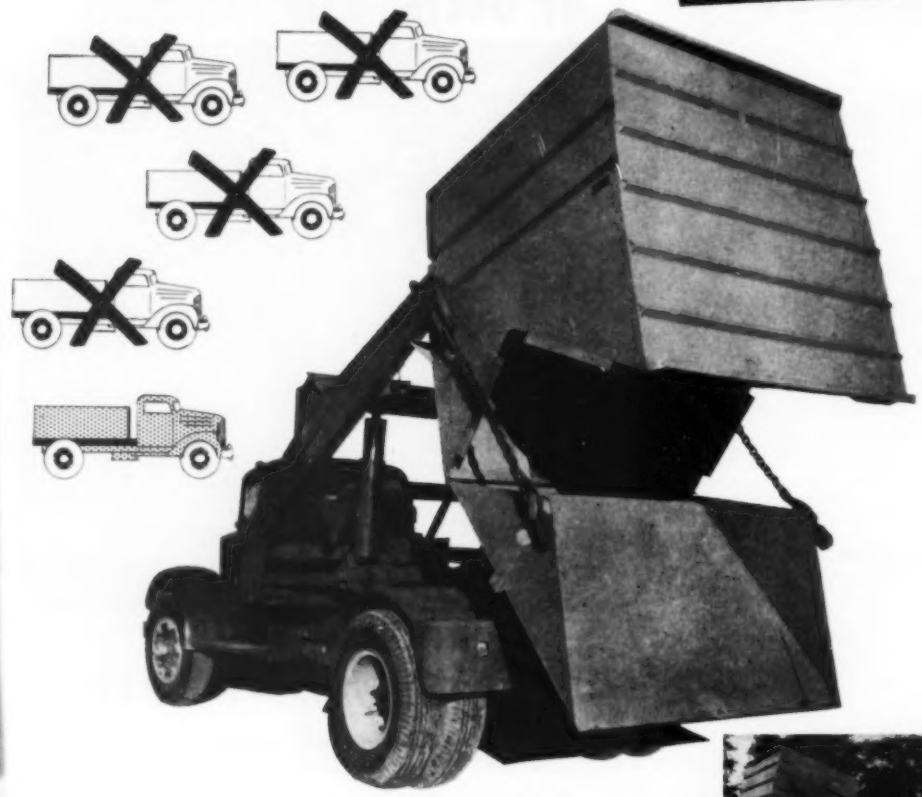

In many plants handling materials by the Dempster-Dumpster System, one truck-mounted Dempster-Dumpster, operated by only one man, the driver, has replaced 3 to 5 conventional trucks and crews. One Dempster-Dumpster services a multiple number of detachable containers in a wide variety of designs best suited to the type of materials handled—be they bulky, light or heavy . . . solids or liquids . . . trash or rubbish. Containers are conveniently located at accumulation points inside and outside buildings. The Type LFW Dempster-Dumpster shown above handles containers up to 12 cu. yds. Containers up to 21 cu. yds. are available with our Type ARLF and DTLF Dempster-Dumpsters. Without question, the Dempster-Dumpster System is the most economical and most efficient method of plant materials handling by truck yet devised! Write today for complete information. Manufactured exclusively by Dempster Brothers, Inc.

DEMPSTER-DUMPSTER, operated by means of hydraulic controls in cab, picks up each container, hauls and empties it or sets load down intact.

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The MONTH... in the INDUSTRY

SEA WATER CORROSION research is being added to Harbor Island Station, pictured above, of the internationally recognized Kure Beach project near Wilmington, N. C. New facilities will include a full-size salt water evaporator and distillation unit to study the effects of water treatment and design on corrosion and scaling of such units. While operated by International Nickel Company under direction of F. L. LaQue, manager of the corrosion engineering section, the Kure Beach project has been conducted on a cooperative basis with producers of competitive materials.

Tollett Again WPRA President

R. L. Tollett, Cosden Petroleum Corporation president, was re-elected president of the Western Refiners Association for the 1952-53 term as the Association chose five new directors at its annual meeting in San Antonio recently. New directors are Bruce K. Brown, pan-American Southern Corporation; F. W. McCurry, Derby Oil Company; Everett F. Wells, Ashland Oil and Refining Company; G. G. Woodruff, Globe Oil and Refining Company, and Max M. Fisher, Aurora Gasoline Company. In addition to Tollett's re-election, four vice presidents were also put back in office for another term. They were J. H. Kennedy, Continental Oil Company; F. L. Martin, Sunray Oil Corporation; Roland V. Rodman, Anderson-Pritchard Oil Corporation, and J. W. Vaiden, Skelly Oil Company.

During the convention Tollett said he thinks current supply position of the industry pretty well rules out any chance for crude price increase. Crude runs to stills will have to come down, but prices will drop first, with lubricants declining most, he said.

"Domestic demand for all oils probably will level off to an average of the year about six percent above that of last year," he stated, continuing, "and removal of government controls on tetraethyl lead probably will result in octane of premium and regular grade gasoline increasing one and two numbers respectively."

In addition to the presentation of technical papers, featured speakers included H. J. Klinger, vice president of the General Motors Corporation and John S. Coleman, president of the Burroughs Adding Machine Company. Klinger is head of General Motors' car and truck group and his talk was of pointed interest to refiners of the gasolines and motor oils. Coleman delivered his highly acclaimed "There Is No Free Lunch" address.

Among the technical papers presented at the meeting three appear in this issue of the REFINER. R. T. Colquette and Carl W. Peters represented their "Economics of Coking Residual Petroleum Products" which appears on page 165; Fowle, Bent, Milner and Masologites' "In Reforming—It's the Catalyst That Counts" is on page 156; and Emory M. Skinner's "The Role of Cost Accounting in Refinery Operating Control" can be found on page 81.

DPA Stamps Official OK On Oil Expansion Program

The Defense Production Administration has approved the $10 billion oil industry expansion program that will begin with the third quarter of this year, extending for an 18-month period, and along with its approval, lifted the goal for refining expansion to an annual rate of 500,000 barrels per day. The original plan submitted by PAD called for an annual rate of 475,000 barrels daily. The program will permit PAD to grant third or fourth quarter allotments for construction of about 250 refinery projects that had been held up by limitations of the old one million-barrel-per-day expansion program. PAD has said that it feels the third quarter allocation gives the expansion program a good start but that trouble is expected in the refining end in obtaining Class B products such as boilers, compressors and heat exchangers over which PAD has no jurisdiction and which are in great demand by other defense industries.

Oil Motion Picture Wins Freedoms Foundation Medal

"Man On The Land," the Oil Industry Information Committee's 1951 motion picture, has been awarded an Honor Medal by Freedoms Foundation, Inc., for making an outstanding contribution to the principles of freedom. The picture, which was produced for the Committee by United Productions of America under the direction of Film Counselors, Inc., tells the story of agriculture from the time that man first scratched the earth with a forked stick to the present age of oil-powered tractors, petroleum fertilizers, insecticides and other petrochemicals. This is the second consecutive year that the Oil Industry Information Committee's motion pictures have been cited by the Foundation.

Union Oil Company Sets Up By-Products Division

Union Oil Company of California has announced establishment of a by-products chemical division to "process raw materials and by-products into marketable chemicals and provide separate administration and development of such activities." As part of the plan, one plant, scheduled to be completed late this year, will make molten sulfur through the recovery of hydrogen sulfide from refinery gases, and another unit will make ammonium sulfate by processing acid sludge and ammonia.

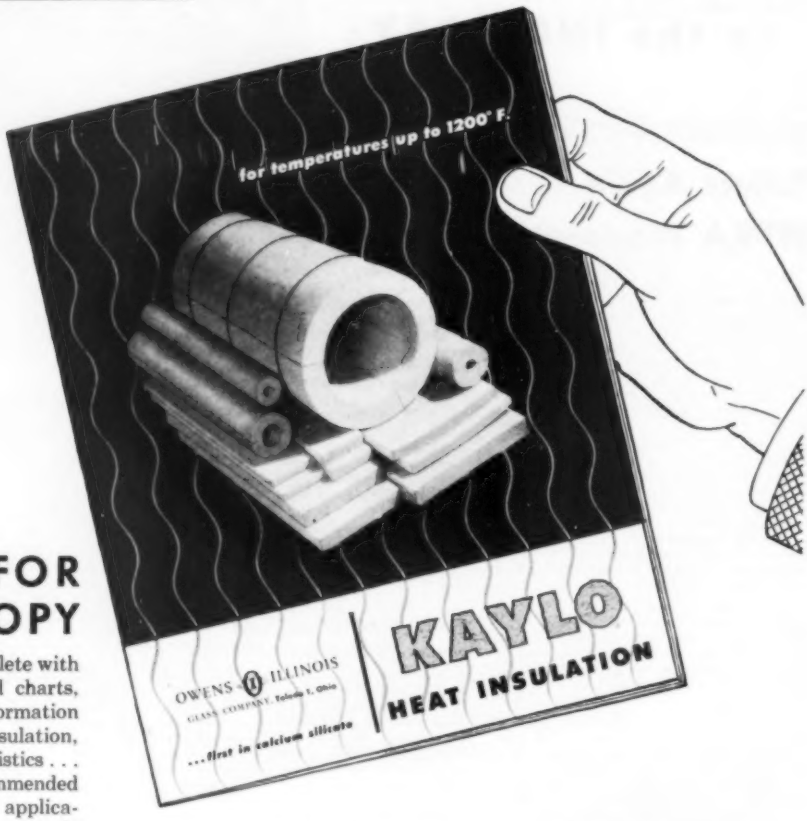
Growing Fischer-Tropsch Use Seen Throughout the World

Germany's Fischer-Tropsch synthesis process, used in the production of high grade petroleum products from coal or natural gas, has a promising future throughout the world, according to Dr. E. H. Tramm, director of Ruhr Chemie AG. Ruhr Chemie employs the process in its German works, and Dr. Tramm said the products turned out could be used not only for the manufacture of high quality gasoline and diesel oil, but also in improving lubricants and kerosine made from natural crude oil. He forecast that the process would be adopted in all coal producing countries within the next 10 years. Large Fischer-Tropsch installations are planned or under construction in various parts of the world. Natural gas is the raw material for the new Carthage Hydrocol synthetic fuel plant at Brownsville, Texas, which uses an Americanized version of the Fischer-Tropsch process. Meanwhile plans for the production of petroleum derivatives by the process are still being developed. A Fischer-Tropsch plant now being built in South Africa will start production of gasoline, diesel oil and kerosine in 1954.

Socony-Vacuum Awards Two 1952 Incentive Fellowships

Socony-Vacuum has awarded 1952 Incentive Fellowships to two of its employees. One award goes to Melvin I. Smith of the technical service department, Brooklyn, N. Y. The other goes to Sidney M. Foulks of the field research laboratories of the Magnolia Petroleum Company, Dallas, Texas, a SoVac affiliate. Under the the terms of the awards, which are offered to encourage scientific studies by company people and to promote better understanding among members of the teaching profession and industry, salaries of both men continue during a period not to exceed three years to enable them to earn higher academic degrees.

Every User Can Profit of Heat Insulation From This New Book



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This useful book, replete with pictures, graphs and charts, contains specific information on Kaylo Heat Insulation, including characteristics . . . efficiencies . . . recommended thicknesses . . . and application data for pipes, vessels and flat surfaces. For your free copy of this book, write: Dept. N-239, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

Kaylo Heat Insulation is a hydrous calcium silicate—the heat-saving material that is revolutionizing insulation practice with its outstanding combination of advantages.

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. . . pioneered by OWENS ILLINOIS **Glass Company**

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HOUSTON • MINNEAPOLIS • NEW YORK • OKLAHOMA CITY • PHILADELPHIA • PITTSBURGH • ST. LOUIS • WASHINGTON

THE OIL MAN'S CALENDAR

APRIL	
16–18	National Petroleum Association, Semi-Annual, Cleveland, Hotel Cleveland.
28–29	Independent Petroleum Association of America, Mid-Year Meeting, Deshler-Wallick Hotel, Columbus, Ohio.
28–30	American Oil Chemists' Socy. (Spring Meeting), Houston, Shamrock Hotel.
30 to May 2	Natural Gasoline Association of America, Annual, Houston, Rice Hotel.
MAY	
11–14	AIChE, Regional, French Lick, Ind., French Lick Springs Hotel.
12–15	API, Div. of Ref. Midyear, San Francisco, St. Francis Hotel.
12–14	LPGA, Annual, Chicago, Palmer House.
26–28	AGA, Production and Chemical Conf., New York, Hotel New Yorker.
27–29	Southwestern Gas Measurement Short Course, U. of Okla., Norman.
JUNE	
2– 4	Instrumentation for the Process Industries Symposium, Engineering, Chemical Engineering Departments, A & M College, College Station, Texas.
23–27	ASTM Annual, Exhibit of Testing Apparatus and Laboratory Supplies, New York, Hotels Statler; New Yorker.
SEPT.	
8–12	ISA Conference and Exhibit, Cleveland, Cleveland Auditorium.
10–12	National Petroleum Assn., Annual, Atlantic City, The Traymore.
14–19	ACS, National (Petroleum Division), Atlantic City, The Traymore Hotel.
OCT.	
9–10	California Natural Gasoline Assn., Annual, Los Angeles, The Ambassador.
20–24	National Safety Council, National Safety Congress and Exposition, Chicago, Conrad Hilton Hotel.
Wk. of Oct. 27	AGA Annual, Atlantic City, Auditorium.
NOV.	
10–13	API Annual, Chicago, Conrad Hilton Hotel and Palmer House.
DEC.	
7–10	AIChE, Annual, Cleveland, Hotels Cleveland and Carter.

T. C. Bodley To Coordinate Building Of Sunray Plant

T. C. (Ted) Bodley, formerly manager of crude oil purchasing and sales for Sunray Oil Corporation, has been transferred to Corpus Christi, Texas, to be coordinator in the building of the company's new refinery. P. M. Broach, former manager of the crude oil trade and exchange section for Stanolind Oil & Gas Company, will succeed Bodley.

Cram Replaces Ferguson on Conoco Board of Directors

Ira H. Cram, vice president in charge of exploration, has been elected a director of Continental Oil Company, succeeding W. H. Ferguson retired executive vice president who resigned as a director but will continue to serve the company in an advisory capacity.

Koegler Is Named Assistant To Jersey Standard's Holman

George Koegler, member of Standard Oil Company (New Jersey) law department, has been made executive assistant to President Eugene Holman, succeeding David A. Shepard, elected to the company's board late in 1951.

Bovay Engineering Firm Develops Into Partnership

H. E. Bovay, Jr., consulting engineers of Houston, formerly an individual professional engineering practice has become a partnership, consisting of H. E. Bovay, Jr., Bennett W. Burns, formerly assistant chief designer, Humble Oil & Refining Company, Charles A. Lawler, previously chief engineer with H. E. Bovay, J. Wayne Holland and Richard B. Robertson, previously senior engineers with the firm.

Bovay

Burns

Holland Robertson Lawler

Eugene Holman Believes Resources Inexhaustible

Eugene Holman, president of the Standard Oil Company (New Jersey), has voiced the idea that the world's oil and other resources are inexhaustible. Putting the idea before the American Association of Petroleum Geologists, he called the nonuse concept of conservation a "fallacy." He traced progressively more efficient and intelligent searches for, and use of various natural resources. Pointing specifically to oil, he said, "It's as though we started out with a tank of oil, used it all up, and had a bigger tankful left." Liquid hydrocarbons, he added, will be taken from oil shales, tar sands, coal and "other sources" not now used, when "and if" it becomes necessary.

Gasoline Tax Shows Big Increase Over 1950 Figures

Gasoline tax revenue rose 10.2 percent in 1951 according to statistics released by the Bureau of Internal Revenue. The total revenue represented $607.7 million as compared to $551.4 million in 1950. This tax is the levy on gasoline during movement from refinery to storage. For December alone, the federal collections on gasoline rose to $53,149,390 from $48,845,076 shown for December, 1950.

Atomic Energy Commission Needs Chemical Engineers

The Atomic Energy Commission has announced that it is in need of persons with chemical engineering training and with 5 to 15 years of experience in large-scale production plant operations, including production supervision, cost analysis and control, and production planning and scheduling. The salary range of several positions to be filled is $7040 to $9360 per year. These positions will be located in Washington, D. C., and in various regional offices in the United States. Those interested in obtaining further information should send full background information about themselves to George M. Gableman, U. S. Atomic Energy Commission, Washington, D. C.

The Month...

Standard Grants $10,000 To Stream Pollution Project

An engineering investigation project in the use of biological warfare to combat stream pollution effects of certain industrial and municipal wastes is being undertaken at the Ohio State University Engineering Experiment station laboratory under a grant of $10,000 made by The Standard Oil Company (Ohio) Sohio has established this test project for an investigation of the destruction of phenols in effluent water from petroleum refineries.

Refinery Expansion in NW Key to Canadian Crude Oil

The pouring of 150,000 barrels per day of Alberta crude oil into the United States to help supply demand for petroleum products in Washington and Oregon has been pictured by D. L. Roberts, Canadian Bechtel vice president. However, before any crude oil from any source can enter the Pacific Northwest, refinery capacity of a substantial nature will have to be constructed in Washington and Oregon.

"There are only three small refineries in Seattle, Spokane and Portland with a combined capacity of 12,000 barrels per day, he pointed out. "Whether new refineries would be economical or competitive as compared with expansion of California facilities and continued movement of products to the Northwest depends on several factors: the prices of competitive crudes, the cost of refining in California versus refining in the Northwest and the ability of California oil fields to meet the entire crude demand of the Pacific coast states."

German Plant Now Producing Hard Paraffin by Synthesis

Krupp-Kohlenchemie GmbH of Wanne-Eickel, a West German concern, has begun production of hard paraffin in modified Fischer-Tropsch installations. The synthesis process was developed by the firm in collaboration with Ruhr Chemie-Oberhausen and Lurgi-Frankfurt/Main. The process is to be used in another plant recently constructed in France which will start production in the near future.

PAD Given Steel Increase By DPA for Third Quarter

The Defense Production Administration has announced it has granted PAD 1,903,750 tons of steel for use in the third quarter of 1952 for oil and gas operations, an increase of 11.5 percent over

All Crudes are Alike to

CHEMISEAL (MADE OF TEFLON) PACKINGS

If you build pumps or valves for Refinery service — or if you are concerned with their maintenance — try Chemiseal, the universal packing material. Made of TEFLON*it is impervious to all petroleum chemicals. There is no need to change packing for different types of crude. It is highly resistant to abrasion, serviceable from −110°F. to 500°F., stands up indefinitely where other packings fail rapidly.

Select Chemiseal Type 810-V packing for Refinery valves. It provides necessary seal at low gland pressures and reduces torque required to operate the valve. Supplied in sets to meet specific requirements.

For Refinery pumps—select Chemiseal No. 711 packing, extremely effective for rotating or reciprocating shafts. Provides a low friction, 2-way seal that not only prevents axial seepage, but also seals against shaft and stuffing box as well. Supplied in sets to meet specific requirements.

For emergency or field service — select Chemiseal Extruded Packing No. 620EG (Graphite impregnated) or 620EM (with Mica). Suitable for valves, pumps, any stuffing box application. Made in continuous lengths, sold by the foot. Ask your supply house or write for catalog.

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FABRICATORS OF "TEFLON", "KEL-F" AND OTHER FLUOROCARBON PLASTICS

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*duPont's trademark for its tetrafluoroethylene resin

The Month...

second quarter allocations. The third quarter allotment was far short of the amount PAD was believed to have requested to continue gas operations and to launch the oil industry's $10 billion, 18-month expansion program scheduled for the third quarter.

Prospects Bright on DPA OK for Oil Expansion Plan

Indications have been strong that the Defense Production Administration will certify PAD's 18-month worldwide oil industry expansion program although no announcement is expected until this month. DPA officials who are studying PAD's proposals say the program will get their support because prospects are good that there will be a general let-up in the material supply situation. Also favoring the plan was the fact that it is not a long-range program based on possible war developments in the near future, but a short-range program based on what industry has indicated it would be able to do should it be given the materials.

Government May Be Weighing Rapid Tax Write-Off Cut

Indications have cropped up recently that the government may be preparing a sharp cutback in rapid tax amortization policy for industrial expansion, including oil. If this occurs, such tax benefits in the oil industry might be limited to special projects, such as aviation alkylate facilities, which are being expanded as a direct contribution to the defense program. Contributing to this line of speculation is Commerce Secretary Sawyer's statement that he feels rapid tax amortization should be continued on a "wholly selective" basis and directed toward trouble spots in defense mobilization.

Latest list of projects approved for fast tax writeoffs appears on page 93.

Chapman Defends Government Synthetic Fuels Stand

Interior Secretary Chapman has reasserted that it is a proper governmental function to spend "millions of dollars to develop synthetic fuel processes, so that private business can adopt them when economically sound." Speaking before a Washington civic group this month, he said:

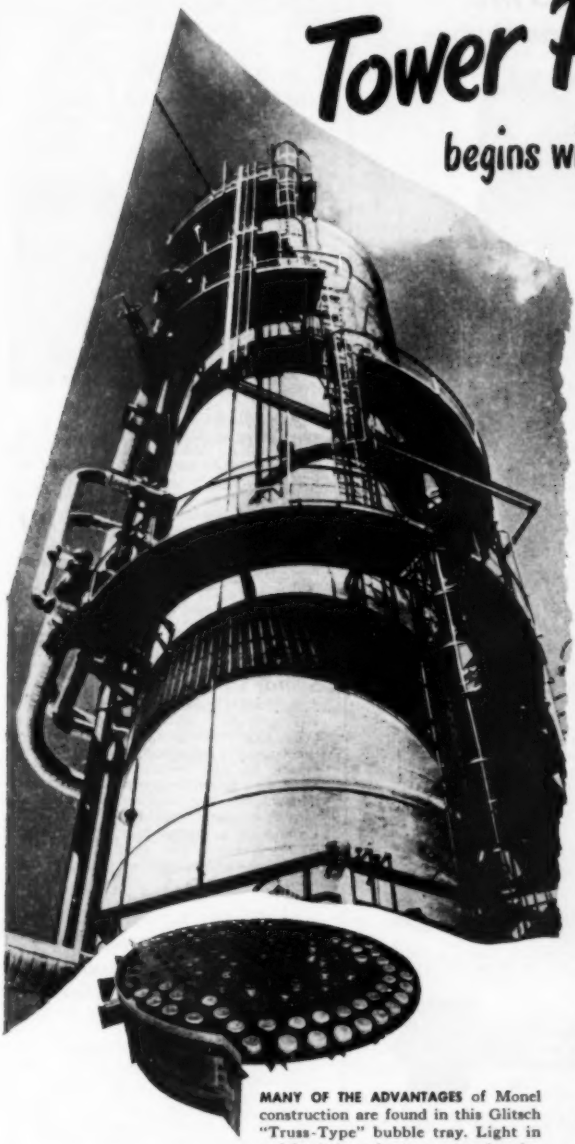
"Our present oil reserves are plentiful, but the experience of World War II brought to many of us the fact that they are not limitless... For this reason we recommended and Congress authorized a synthetic liquid fuels program as insurance against the day when natural oil is depleted."

Ben Franklin Plant Blast Causes $200,000 Damages

The explosion and fire at Ben Franklin Refining Company's Ardmore, Okla., plant earlier this year has resulted in $100,000 to $200,000 damage, company officials have estimated. Three lives were lost in the blast, of undetermined origin, which occured at the approximate center of the refinery and halted operations for 60 days. Buildings housing the refinery's chemical laboratory and controls and boiler rooms, were destroyed by the blast and flames which were out of control

In designing for all types of crudes...

Tower Protection begins with Monel!



Design engineers seldom know, these days, what the next crude will be like.

Today sweet—tomorrow sour. Or maybe a mixture of both. That's why top sections of fractionating towers need *plenty* of protection against corrosion.

And they get this protection from MONEL*. That has been proved time and again in every refining center.

When the M. W. Kellogg Company designed a large refinery for charging a sour crude containing in the neighborhood of 2% sulfur, they knew special problems would arise. Experience had shown, for example, that most commercial metals used in the top sections of the fractionating vessels would pit, due to corrosive action by sulfur and salt compounds in condensed water vapor.

Consequently Kellogg engineers recommended Monel-lined nozzles for refluxing in top tower sections for temperatures of 400°F. or below. Monel does not pit under these conditions, and Kellogg knew it would display satisfactory resistance to predicted corrosion in the upper tower sections where temperatures below the dew-point are encountered.

Monel, as a matter of fact, is highly resistant to sulfur attack at temperatures up to 500°F. It resists corrosion by sulfuric acid, dilute hydrochloric acid, brines, sour crudes, caustics and chlorinated solvents. Its high strength and low corrosion rate make possible the use of thin, lightweight sections that save you money in both material cost and tower design.

Before you choose a metal for top tower sections, investigate Monel. Get all the facts now; write for information and technical data, today. And remember, when ordering, to anticipate your needs. Order well in advance, *giving N.P.A. rating and complete end use information.*

MANY OF THE ADVANTAGES of Monel construction are found in this Glitsch "Truss-Type" bubble tray. Light in weight, it is easier to erect and maintain. Monel's ductility eliminates breakage during installation and cleaning... Smooth, corrosion-resistant Monel surfaces increase tower efficiency, reduce coking hazards. And Monel caps and trays, if distorted by explosion, can be readily straightened and restored to service... *This photo used through courtesy of the fabricator, Fritz W. Glitsch & Sons, Dallas, Tex.*

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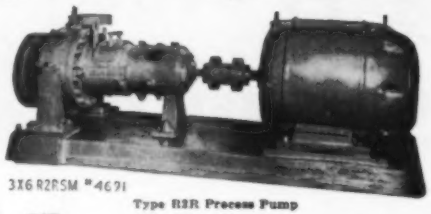
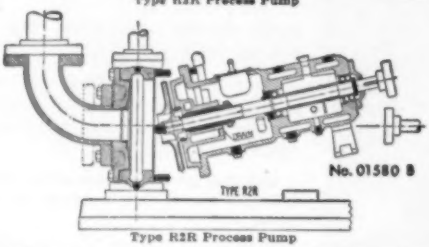
DEAN BROTHERS PUMPS INC.
Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

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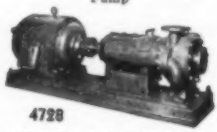
4044M
Close Coupled Centrifugal Pump

3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump


4728
Double Pedestal Bearing Centrifugal Pump

3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869
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Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS
Representatives in Principal Cities

The Month . . .

about six hours. A proposed $2 million expansion project at the plant will not be affected.

C. R. Miller Installed as Head of Houston ISA Group

C. R. Miller, General Tire and Rubber Company, Baytown, Texas, has been installed as president of the Houston section of The Instrument Society of America. The installation took place at the group's annual dinner meeting in Houston.

Miller

Other officers installed were J. R. Martin, Humble Oil & Refining Company, Baytown, vice president; Tony Costa, Westcott & Gries, Inc., Houston, secretary; R. E. Hughes, Shell Chemical Company, Deer Park, treasurer; R. E. Houlihan, Maintenance Engineering Company, Houston, program chairman; R. G. Marvin, Dow Chemical Company, Freeport, constitution chairman; Bob Molnari, Egglehof Engineering, Houston, membership chairman; R. E. O'Neill, Industrial Scientific, Inc., ISA councilor; C. L. Schultz, Shell Oil Company, Deer Park, alternate ISA councilor; and R. C. King, Dow Chemical Company, Freeport, publicity chairman and outgoing president.

Whaley Transferred To Sunray's Tulsa Offices

William C. Whaley, Los Angeles, a vice president and director of Sunray Oil Corporation, has been transferred to the company's general offices in Tulsa, where he will become a member of Sunray's executive committee and chairman of the company's operating committee, succeeding C. H. Wright. R. E. Foss, vice president of Sunray's west coast division, has been named vice president and manager of the company's operations there to succeed Whaley. Paul E. Taliaferro, director and vice president, will be vice chairman of the operating committee.

Standard Indiana Advances Seebold to Research Office

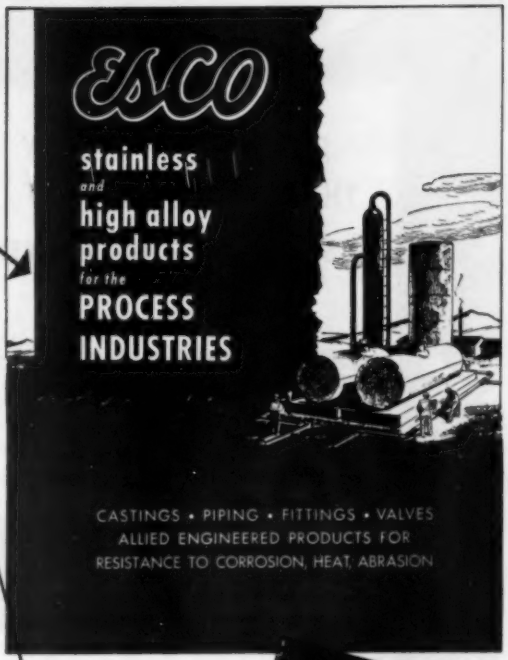
James E. Seebold has been promoted to assistant manager of research of Standard Oil Company (Indiana) with headquarters in Chicago. Robert A. Steel has been promoted to succeed him as director of the process division at the company's Whiting, Ind., research laboratories. Seebold joined Standard in 1940 as a chemical engineer at Whiting and was subsequently group leader, section leader and assistant director of research before becoming director of the process division in 1950. Steel joined Standard in 1938 as a chemical engineer. After serving also as a group leader, he was appointed section leader in 1946.

J. E. Toussaint Named VP By Standard of California

J. E. Toussaint, general manager of the production department of Standard

a new guide to better operation

through effective resistance to corrosion, heat and abrasion



Here's a brand new catalog containing detailed information on stainless and high alloy equipment that will help you overcome the problems of corrosion, heat and abrasion in your refinery.

In addition to an explanation of the different types of corrosion and recommended analyses for meeting the various corrosion problems, the catalog includes data on the following:

- **Heat resistant castings**
- **Abrasion resistant castings**
- **Centrifugally cast pipe and bushing stock**
- **Dimensions on screwed, flanged and welding fittings**
- **Corrosion resistant valves**
- **Corrosion and heat resistant conveyor chains**
- **Wrought stainless pipe, tubing, light wall fittings**
- **Useful tabular data on bars, tubing, fittings, etc.**
- **Corrosion resistance of principal alloys to most common corrosive agents**

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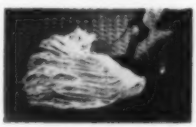
GRIPS WITHOUT A SLIP. Engineered design of SUPER-DIAMOND puts 40 traction points in every footstep. All-over pattern gives foot-safety from every angle.

EASY TO CLEAN. SUPER-DIAMOND has no dirt-catching corners. It's easy to clean with hose, mop or broom.



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The Month...

Oil Company of California for the past seven years, has been named a vice president of the company. He joined Standard as a construction engineer in the company's Richmond refinery 30 years ago and held a number of engineering jobs before turning to oil field production work. He was named general manager of operations for Standard's producing department in 1941 and was selected to head that department in 1945.

Hanna Named Superintendent Of Standard-Vacuum Plant

John B. Hanna has been named general superintendent of the new refinery which Standard-Vacuum Refining Company of South Africa (Pty.), Ltd., will build at Durban, Union of South Africa. Until recently, Hanna was supervisor of maintenance and construction at Esso Standard Oil Company's Bayway refinery. Hanna joined Esso Standard in 1935 and transferred to the Standard-Vacuum Oil Company's South African affiliate early this year.

Hanna

Mangum Webb Elected VP Of Chemical Construction

Mangum Webb, sales manager of Chemical Construction Corporation, has been elected vice president of the firm. He joined Chemical Construction in 1914 when it was founded, and has served as Far Eastern representative, procurement director and assistant sales manager and director of engineering of the Ion Exchange department of American Cyanamid Company, the parent firm.

R. W. Baker Named to Manage Shell Research Division

R. W. Baker, marketing analyst for Shell Oil Company, has been promoted to manager of the research and analysis division of the company's marketing administrative office. At the same time, J. E. Morehouse, supervisor of methods and procedures, becomes manager of his division. Baker will handle general marketing research, analysis of marketing expense and sales trends, coordination of forecasting and special marketing statistics. Morehouse will take care of price records, studies of marketing organization, handling of government bids and coordination of marketing service procedures.

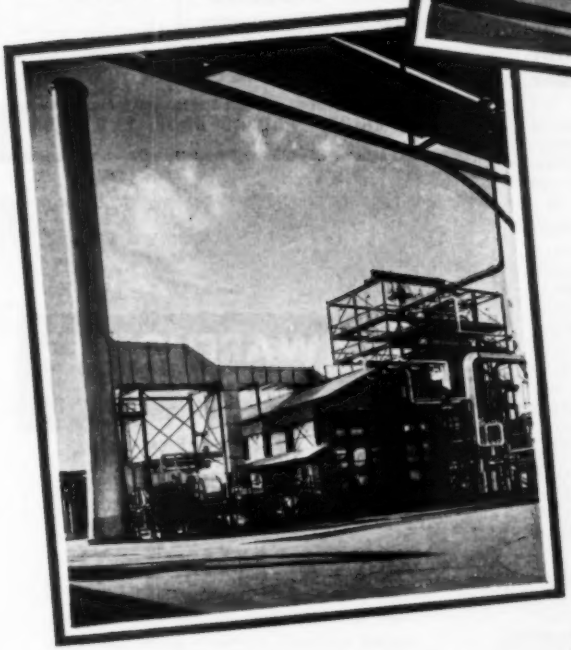
Standard-Vacuum Announces Resignation of J. C. Sample

Standard-Vacuum Oil Company has announced that it has accepted the resignation of J. C. Sample, effective April 15. Sample has been a director of Standard-Vacuum since joining the company in 1949 and has been in charge of the company's operations in South Africa, Australia, New Zealand and Japan. He also represented Standard-Vacuum on the National Foreign Trade Council and the Foreign Petroleum Supply Commit-

These Brick Have Quick Temperature "Reflexes"

Low heat storage and conductivity! That's the reason B&W Insulating Firebrick heat or cool fast. This quick temperature reflex provides precision control in chemical and petroleum furnaces. Processes can be started — or stopped — quickly. Also important — when furnaces are shut down, there is no long delay before they can be entered for inspection.

Views of Alcorn Combustion Co. crude heater for Continental Oil Co., Ponca City, Oklahoma.



The defense plant expansion program has created unprecedented demands for B&W Insulating Firebrick. It is, therefore, necessary to anticipate your requirements as far in advance as possible.

SAVE MONEY
3 Other Ways, Too

LOW INSTALLATION COSTS
B&W Insulating Firebrick are light, simple to install. They can be cut, drilled or shaped on the job with ordinary woodworking tools.

NO EXPENSIVE ALLOYS
These high-insulating brick can be supported by ordinary carbon steel hangers . . . don't require expensive, heat-resisting alloys.

STAYING POWER
B&W Insulating Firebrick withstand severe service for years . . . keep maintenance costs to a minimum.

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How to add POWER to a Pneumatic Control System

FAST, POSITIVE OPERATION OF DAMPERS and LARGE VALVES

with a 3-15 p.s.i. air signal and Askania Hydraulic Power

The Askania Remote Valve Positioner accurately positions a hydraulic cylinder in direct proportion to a pneumatic signal of 3 to 15 p.s.i. to within 1% of full cylinder stroke. At the same time, it produces an air signal that may be used to indicate the exact position of the valve.

The 3 to 15 p.s.i. signal is applied to a bronze bellows that positions the Askania Jet Pipe. The Jet Pipe governs oil flow to either end of the valve cylinder. As the valve moves, the feedback resets the hydraulic relay, so that for any air loading there is a definite, predetermined position of the valve. The Askania Remote Valve Positioner is sturdy, rugged and weatherproof, suitable for inside or outside installation. The Positioner can be supplied to react to air pressure failure in one of three ways: (1) to drive the valve open, (2) to drive the valve closed, or (3) to lock the valve in its intermediate position.

There is no hunting or cycling—a change in air pressure sends the positioning cylinder to a certain position and it stays there. Operation is fast and powerful. For example, a 3" x 8" cylinder will travel full stroke in 2 seconds at no load with a large capacity ¾" booster, in 4 seconds at 50% of stalling load.

The Remote Valve Positioner is one of the several Askania hydraulic valve operators designed to add muscle to pneumatic control systems. Form I-87 describes the Air-Hydraulic Crank Cylinder; Form I-86 describes the Air-Hydraulic Slide Valve Positioner. Write for both papers.

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CORPUS CHRISTI
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The Month...

tee. He plans to return to California where he will rejoin the board of General Petroleum Corporation.

Maintenance Engineering Elects Gautier to VP Post

C. W. Gautier, secretary-treasurer of Maintenance Engineering Corporation of Houston for the past 10 years, has been elected vice-president of the firm. A veteran of almost 25 years service with Maintenance, Gautier is a native of New York, but received his education in Texas. After graduation from college with a degree in business administration, he became associated with the S.A. & A.P. and later the Southern Pacific railroads in their executive departments. Gautier joined Maintenance in 1928.

Gautier

Instrumentation Symposium Scheduled By Texas A.&M.

Texas Agricultural and Mechanical College has announced its seventh Instrumentation for the Process Industries symposium to be held at College Station, Texas, June 2-4. The series began in 1946 and is designed to lead to an improved understanding of the principles and practice of instrumentation as applied to processing industries employing the continuous flow of fluids. Particular attention will be given to new developments and the material will be on a practical engineering level. The talks will be directed toward all engineers whose work requires knowledge of industrial instrumentation.

James Stanley Promoted To Section Head By Standard

Standard Oil Company (Indiana) has promoted James K. Stanley from senior projects metallurgist to section head in the materials division of the engineering research department. Stanley joined Standard in 1950 after 13 years' service with Westinghouse Electric Research laboratories as research metallurgist. He is a graduate of Vase Institute of Technology and received a Ph. D. degree from the University of Pittsburgh in 1948.

William Brooks Heads Tank Fabricators for LPAG

William H. Brooks, new executive manager of the recently organized Tank Fabricators Committee, operating under the administration of the Tank Fabricators Section of the LPAG, will make his headquarters in Washington, D. C., and his immediate duties will be concerned principally with the procurement of steel and other critical materials for the production of LP-Gas storage tanks.

General Petroleum Appoints Cortelyou Chief Engineer

C. G. Cortelyou has been appointed chief design engineer of the General Petroleum Corporation's engineering department. He succeeds A. K. Brum-

you can lose plenty if you're

UNDER-TRAPPED

It doesn't pay to skimp on traps . . . especially steam traps. Water and air in steam lines reduces effective temperatures, wastes fuel and adds to maintenance costs.

Clark Steam Traps have proven their outstanding drainage efficiency over many years of use in thousands of plants. Now, with the new Duo-Step double-drainage capacity feature, they can handle twice the condensate of ordinary traps.

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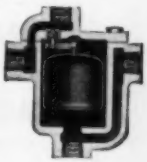
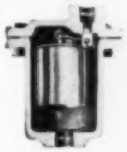
QUICK CLEANING STRAINERS. Remove dirt, scale and grit from steam, fluid and gas lines. Sizes ½" to 3" I.P.S.

SERIES "40" INVERTED BUCKET TRAP. Choice of horizontal or vertical inlet or outlet. For pressures up to 150 P.S.I. "Clark-lay" guided disc and seat.





CLARK "701"-D (DUO-STEP) TRAP. A forged steel trap for pressures up to 500 P.S.I. and temperatures of 750°F. Equipped with "double-drainage" Duo-Step leverage and venting, Clark-lay seats and discs. Pipe sizes ½" or ¾".

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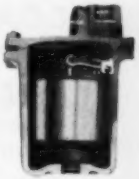

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PAGE Welding Electrodes AND Rods

The Month...

baugh who has joined the refinery engineering department of the Socony-Vacuum Oil Company, Inc. Cortelyou has been with General Petroleum since 1938.

So-Vac Transfers Baker To Manufacturing Group

Charles P. Baker, manager of the Socony-Vacuum Oil Company, Inc., refinery in East St. Louis, Ill., has become a member of the company's manufacturing committee, which coordinates all manufacturing activities at Socony-Vacuum refineries throughout the world. Oliver C. Johnson, operating superintendent at the refinery, will succeed Baker as manager.

Baker, a Texan, joined the Magnolia Petroleum Company, Socony-Vacuum affiliate, at Dallas, Texas, in 1934. A graduate of the Agricultural and Mechanical College of Texas, he will make his headquarters in New York.

November 9-13 Set for 1953 Annual API Meeting

The executive committee of the American Petroleum Institute board of directors has announced that next year's annual meeting will be held in Chicago, November 9-13. At the same time the committee announced it would defer action on the recommendation of the general committee of Division of Marketing that proposed new motor oils be designated by service classifications, until the next full board meeting April 29-30 in Tulsa.

Szekely Elected President At Annual ASHVE Meeting

Ernest Szekely, president of the Bayley Blower Company, Milwaukee, Wis., has been elected 1952 president of The American Society of Heating and Ventilating Engineers, it was announced at the society's annual meeting in the Hotel Statler.

Other officers elected were: vice president, Reg F. Taylor, consulting engineer of Houston, Texas; vice president, L. N. Hunter, vice president of research, National Radiator Company, Johnstown, Pa.; treasurer, J. Donald Kroeker, consulting engineer, Portland, Ore.

B-A Staff At Calgary Wins No-Lost-Time Year Benefit

The staff of the British American Oil Company refinery at Calgary has completed 365 days without a lost-time injury to mark the third time in six years that the staff of 118 have become eligible for the company president's award of one full day's pay in recognition of their contribution to B-A's safety program.

British American has an intensive safety program and employs a full-time safety supervisor in all its refineries and marketing divisions.

American Cyanamid Announces Formation Of New Subsidiary

American Cyanamid Company has announced the formation of a new corporation, Chemical Construction (Inter-American) Ltd., a subsidiary of Ameri-

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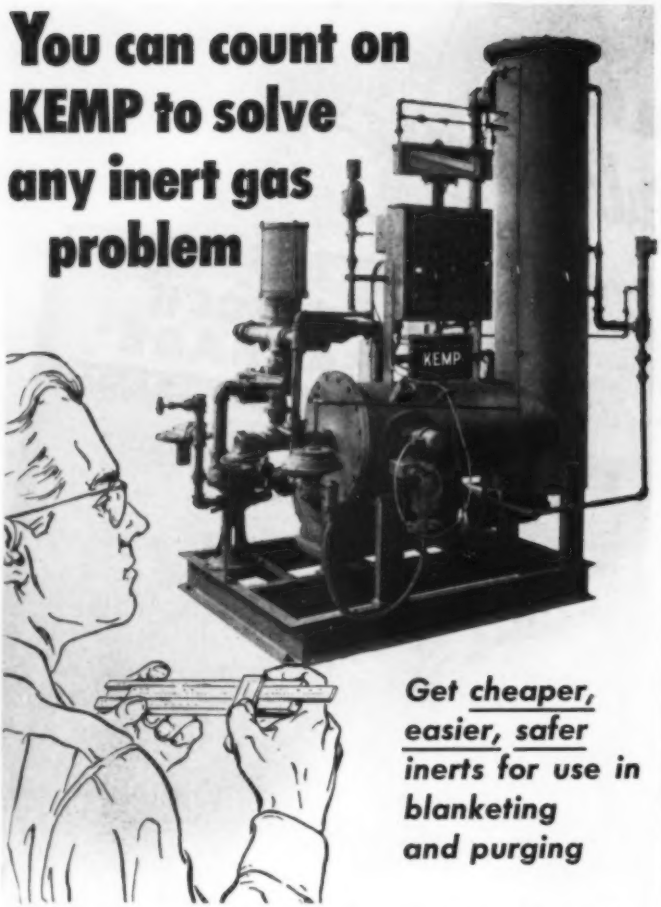

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Write for Bulletin I-10 for technical information

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The Month...

can Cyanamid. The new firm will design and build chemical plants in all nations of the western hemisphere except the United States. President of the new company is W. R. Geddes, former assistant to the president of North American Cyanamid Limited.

Five Year Progress Report Made by Petroleos Mexicanos

Notable progress in every phase of Mexican petroleum operations has been reported in a five year summary by Senator Antonio J. Bermudez, director general of Petroleos Mexicanos (Pemex), the government oil and gas administration. Also outlined in the summary was a projected large scale Pemex program, one of the chief undertakings being the new 2200 barrel per day lubricants plant at Salamanca, construction of which started in March. Construction of three proposed west coast refineries, a 20,000 barrel per day catalytic cracking plant at Ciudad Madero, and a 5000 barrel per day catalytic cracker at Minatitlan are being held up by unavailability of building materials. Projected, also, is a large plant to extract natural gasoline from gas produced in the northern fields.

Shale Oil Pilot Plant Operations Begin in Brazil

Two shale oil projects are reported underway in Brazil in the form of pilot plants at Sao Mateus, and between Rio de Janerio and Sao Paulo. The Sao Mateus project, being constructed by the state government, is a $500,000 plant with a capacity of 100 barrels per day. Cia Industrial de Rochas Betuminosas operates a pilot plant between Rio and Sao Paulo with two retorts producing 20 barrels per day in operation and two nearing completion. The company has announced plans to construct a 2500 barrel per day plant if the pilot plant proves successful.

Bureau of Mines Desires Coal-Oil Plant in Wyoming

Continuing its drive to secure a commercial synthetic fuel oil program, the Bureau of Mines has quoted $149,980,000 as the probable cost of building a 15,000-barrel-daily coal-hydrogenation plant in Wyoming. The total capital requirement will run about $174.5 million, not including housing for employes, according to L. C. Skinner, chemical engineer at the Bureau's synthetic fuels demonstration plant at Louisiana, Mo. Lake De Smet, about 25 miles from Sheridan, Wyo., was selected because strip mining could deliver coal to the proposed plant for 75 cents per ton, according to Bureau figures. The plant design would include a platformer unit to capitalize the value of aromatic products recovered.

Grants Given Colleges

An educational grant to the Ohio Foundation of Independent Colleges by the Standard Oil Company (Ohio) will total about $70,000 when present negotiations are completed. Sohio policy supports independent higher education on the "recognized" grounds that private education and private business have much in common, since "both must suc-

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The Month...

ceed or fail directly on their respective contributions to the public welfare."

Laminack Moves to New York To Head So-Vac Training

E. R. Laminack, training director at the Beaumont, Texas, refinery of Magnolia Petroleum Company, has been appointed manager of training activities for the parent Socony-Vacuum Oil Company, Inc. With the appointment effective this month, Laminack will begin his duties at company headquarters in New York. A member of the Magnolia refining division industrial relations staff since late 1944, he previously had held positions in the Beaumont refinery as stillman, shift foreman and night superintendent. Laminack attended Lamar College, Beaumont, and Southern Methodist University in Dallas.

McDaniel Transferred To Toledo by Sohio Promotion

Kenneth A. McDaniel, process superintendent at the Standard Oil Company (Ohio) refinery at Lima, has been promoted to general superintendent of the Toledo plant succeeding Clyde O. Rowley who retired early this year. McDaniel is a chemical engineering graduate of Ohio State University and began his industrial career with the Ashland Oil and Refining Company in Kentucky. He has been an employe in the Lima refinery for the past 15 years.

API Refining Program Listed

The 17th midyear meeting of the Division of Refining of the American Petroleum Institute, which will be attended by hundreds of refiners, technologists and industry executives, will be held in San Francisco's St. Francis Hotel May 12-15, inclusive.

Ten group technical sessions and an open dinner meeting are on the four-day program. Among the subjects to be covered are analytical research, electrical equipment, corrosion, industrial communications, automotive fuels, production and recovery of aromatics, and atmospheric pollution.

The central theme will be industrial communications. An interesting session is being built around this subject in itself, and at least three papers will be presented, according to W. M. Holaday, New York, program chairman.

The tentative program has been announced as follows:

MONDAY, MAY 12

9:00 a.m.—Analytical Research

"Micro Flash-Point Determination on Petroleum Products," Philip McCutchan and D. A. Young, Union Oil Company of California, Brea, Calif. "Improved Apparatus and Procedure for the Direct Semi-Micro Determination of Oxygen in Organic Substances (Carbon Reduction—Titrimetric C_{02} Method)," R. D. Hinkel and Raphael Raymond, Office of Synthetic Liquid Fuels, Bureau of Mines, Pittsburgh. "Determination of Nitrogen in Petroleum and Shale Oil," Subcommittee on Nitrogen Determination, API Committee on Analytical Research, New York. "Effect of Multi-Testing on Refinery Production Costs," M. R. Morrow and G. T. Shewell, Humble Oil & Refining Company, Baytown, Texas.

2:00 p.m.—Electrical Equipment

"Better Power-System Performance Through Better Protection," D. L. Beeman, General Electric Company, Schenectady, N. Y. Thermo-Plastic Insulated Wire and Cable," W. J. Delehanty, General Electric Company, Oakland, Calif.

2:00 p.m.—Analytical Research

"The Determination of Polythionic Acids," Raymond R. Jay, Sinclair Research Laboratories, Inc., Harvey, Ill. "Polarographic Studies of Sulfur Compounds in Petroleum Fractions," M. E. Hall, Humble Oil and Refining Company, Baytown, Texas. "The Determination of Sulfur in Petroleum Distillates by X-ray Absorption," A. Y. Mottlau and C. E. Drisens, Jr., Standard Oil Development Company, Linden, N. J. "A Comparative Study of Three Methods for the Determination of Vanadium in Silica-Alumina Cracking Catalyst," M. D. Grimes, J. E. Puckett, Dotty M. Goard, H. M. Smith and B. J. Heinrich, Phillips Petroleum Company, Bartlesville, Okla. "A Spectrographic Method for the Analysis of Cracking Catalysts," C. W. Key and G. D. Hoggan, Richfield Oil Corporation, Wilmington, Calif. "Safety Problems in Analytical Research," Louis Jacobson, Shell Chemical Company, Emerysville, Calif.

TUESDAY, MAY 13

9:00 a.m.—Corrosion

"Economics of Metals and Coatings to Combat Corrosion of Refinery Tank Roofs," H. F. McConomy and J. J. Hur, The Atlantic Refining Company, Philadelphia. "Internal and External Protection of Storage Tanks," J. S. Cook, Humble Oil & Refining Company, Baytown, Texas. "Corrosion of Refinery Equipment by Sulfuric Acid and Sulfuric-Acid Sluges," H. J. Hafsten, Standard Oil Company (Indiana), Whiting, Ind. "Experience with Corrosion in Girbotol Plants," H. M. Wilten, The Texas Company, Port Arthur, Texas. "Corrosion Inspection as a Part of Safety," J. H. Crian, Sun Oil Company, Philadelphia.

TUESDAY, MAY 13

10:00 a.m.—Electrical Equipment

"Mineral Insulated-Metal Sheath Wiring: A Review of its Characteristics and Applications," W. C. Warr, General Cable Corporation, Perth Amboy, N. J. "Safety Aspects of the National Electrical Code," Frank Short, Western Oil and Gas Association, Los Angeles.

2:00 p.m.—Training

An interesting session is being developed. There will be three papers on the subject of "Communications in an Industrial Organization," and a Safety Minute man as follows: "Fire-Protection Training," J. E. Hill, Union Oil Company of California, Los Angeles.

2:00 p.m.—Automotive Fuels

Presiding: T. B. Rendel, Shell Oil Company, New York.

"Engine Variables Affecting Octane Number Requirement," H. A. Bigley, Phillips Petroleum Company, Bartlesville, Okla.; A. E. Cleveland, The Ford Motor Company, Dearborn, Mich.; and G. E. Onishi, The Studebaker Corporation, South Bend, Ind. Subject to be announced, Kenneth Boldt, The Pure Oil Company, Crystal Lake, Ill.

(Session sponsored by Automotive Research Committee).

WEDNESDAY, MAY 14

9:00 a.m.—Production of Aromatics

"Three Years of Commercial Platforming," Vladimir Haensel, H. W. Grote, P. C. Weinert, and M. J. Sterba, Universal Oil Products Company, Chicago. "Houdriforming at Low Pressure," J. C. Dart, A. G. Oblad, and J. W. Schall, Houdry Process Corporation, Philadelphia. "Thermofor Catalytic Reforming (TCR)," J. W. Payne and L. P. Evans, Socony-Vacuum Laboratories, Paulsboro, N. J.; and E. V. Bergstrom and V. O. Bowles, Socony-Vacuum Oil Company, Inc., New York. "Fluid Hydroforming for 95-Octane Gasoline," R. M. Shephardson and C. W. Tyson, Standard Oil Development Company, Linden, N. J.; and A. Voorhies, Jr., Esso Standard Oil Company, Baton Rouge. "Tomorrow's Octanes," G. P. Masologites and R. D. Bent, The Atlantic Refining Company, Philadelphia.

2:00 p.m.—Recovery of Aromatics

"The Arosorb Process in Refinery Operations," W. H. Davis, E. R. Weatherly and J. L. Harper, Sun Oil Company, Marcus Hook, Pa. "A Proven Process for Recovery of High-Purity Aromatics," C. L. Dunn and G. E. Liedholm, Shell Development Company, Emeryville, Calif. "Production of High-Purity Aromatics for Chemicals," Davis Read, Universal Oil Products Company, Chicago. "Electrolytic Regeneration of Treating Solutions," Charles W. Rippie and Oliver Zandra, American Development Corporation, New York.

WEDNESDAY, MAY 14

7:00 p.m.—Open Dinner Session

Presiding: W. L. Stewart, Jr., vice president for refining API; Union Oil Company of California, Los Angeles.

"The Responsibilities of an API Committee Member," W. L. Stewart, Jr., vice president for refining.

Address: Dr. L. A. DuBridge, president, California Institute of Technology, Pasadena.

THURSDAY, MAY 15

9:00 a.m.—Atmospheric Pollution

"Smog, Science, and Fiction," Paul L. Magill, Richard D. Cadle, and Frederic G. Sawyer, Stanford Research Institute, Stanford, Calif. "The Policeman is Coming," Vance M. Jenkins, Union Oil Company of California, Brea. "A Paper on Waste Gas Disposal," Aurora Gasoline Company, Detroit. "Disposal of Radioactive Wastes," J. W. McCaslin, Phillips Petroleum Company, Bartlesville, Okla.

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1951:									
January 27	6,066	6,483	244,220	21,106	126,261	9,954	58,997	9,905	40,378
February 24	5,954	6,534	237,304	20,818	136,870	10,545	48,764	9,471	38,995
March 31	6,041	6,351	233,956	20,398	142,186	9,365	43,170	9,147	37,282
April 28	6,154	6,236	242,479	19,876	137,474	8,061	43,859	8,747	36,080
May 26	6,163	6,430	246,400	21,102	130,819	8,580	51,344	9,045	37,365
June 30	6,181	6,595	247,299	21,666	126,844	8,542	65,700	9,036	41,097
July 28	6,205	6,396	251,203	21,539	121,156	8,174	76,938	8,858	44,967
August 25	6,220	6,500	252,257	21,592	115,934	8,761	85,543	8,763	46,753
September 29	6,303	6,558	253,519	21,068	112,356	9,124	97,019	8,332	47,566
October 27	6,340	6,461	259,852	22,364	111,120	9,380	102,106	8,433	49,168
November 24	6,232	6,757	260,465	22,181	111,698	9,428	98,986	9,305	47,591
December 29	6,204	6,763	256,437	22,478	122,558	10,522	83,792	9,371	43,571
1952:									
January 26	6,194	6,384	253,186	21,649	133,861	10,391	66,450	9,222	38,725
February 23	6,366	6,599	255,184	21,528	141,765	10,552	55,055	9,024	37,111
March 29	6,402	6,390	253,168*	21,837	149,631	9,712	45,109	8,846	35,593

* March 22, Stocks.

PAD Asks Industry to Meet Increased Avgas Demands

PAD Deputy Bruce Brown has called on the nation's refiners to increase their output of aviation gasoline, declaring that the supply situation continues critical and the military has boosted April requirements.

"If the industry is to meet the needs of all users during the next few months," he said, "production of aviation gasoline must be stepped up appreciably over current levels."

Lead Restrictions Lifted Due To Increased Supply

Government restrictions on the use of lead were recently removed as a result of substantially increased supplies made available to the American consumer, the Lead Industries Association

PETROLEUM CHEMICALS DIVISION
NEWS

April ★ One of a Series of Interest to the Petroleum Industry ★ 1952

Hundreds of Requests for "Pipeline on Wheels" Channeled to Oil Companies

The demand for Du Pont's new movie, "Pipeline on Wheels" has been far heavier than anticipated.

The film, specially designed for oil companies to use in their own public relations programs, shows how gasoline tank trucks are made safe to operate on public highways. It is suitable for showing to civic organizations, state and municipal officials, association meetings and other similar groups.

An unexpectedly large demand for the film sprang up from non-oil organizations such as insurance companies, fire departments and other interested groups and hundreds of these organizations requested the film for their own use. But, because of Du Pont's policy to distribute the film exclusively through the oil companies, these groups have been asked to request a showing from their regular petroleum supplier . . . thus creating public contact opportunities for the oil companies.

New Information on Gasoline Storage Stability

Modern gasolines are modifying our conception of gasoline stability . . . and the ways of measuring it.

Although gum complaints have been few, there has been a growing feeling among refiners that induction period tests are not as satisfactory for predicting storage stability of modern gasolines as they were when applied to earlier fuels.

Some new light was recently thrown on this problem in a paper, "Stability of Present-Day Gasolines," presented by Richard O. Bender at the February meeting of the Western Petroleum Refiners Association in Beaumont, Texas.

This paper, co-authored by N. D. Lawson, A. R. Kernen and R. O. Bender, all associated with the Du Pont Petroleum Chemicals Division, deals with the relationship between accelerated laboratory tests and storage test results, and the effect of additives as measured by these tests.

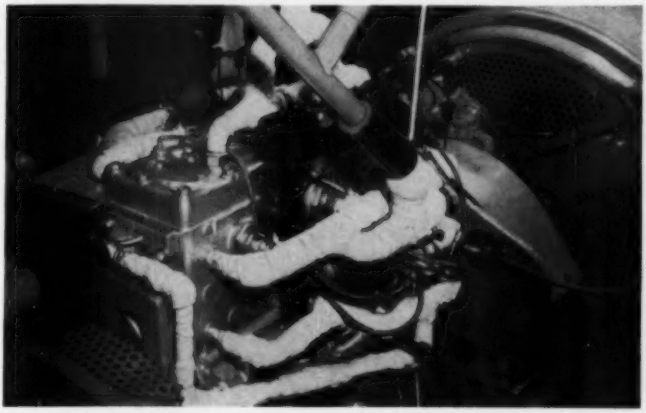
The data presented in the paper are based on laboratory storage tests at 110° F., conducted by the Du Pont Petroleum Laboratory. It indicates that induction periods of modern gasolines do not correlate with stability behavior in this type of storage. The tests also indicate that Metal Deactivator provides much greater storage stability than can be predicted from accelerated tests.

Since much of the information presented in the paper is at variance with accepted concepts of storage stability, it is stimulating discussion in the refining industry. Copies of the paper are available to you through the Du Pont Petroleum Chemicals Division district offices.

Du Pont Petroleum Research Finds New Answers to the Problem of "Knock"

Continuing Du Pont Deposit Studies Offer New Data On How Engine Deposits Affect Octane Requirements

Why does an engine have an increasing tendency to knock during the first few thousand miles of operation? If, as generally believed, deposits are a contributing factor, *how* do they contribute? And do "leaded" gasolines accentuate the increase in knocking tendency?



A PRODUCTION MULTI-CYLINDER AUTO ENGINE was used for studying the thermal insulating effect of engine deposits at the Du Pont Petroleum Laboratory.

The Du Pont Petroleum Laboratory set out to find the answers to these questions and came up with some very interesting results.

The Du Pont research workers found, for example, that knocking tendency of the combustion chamber deposits is independent of the amount of both tetraethyl lead and sulfur present in commercial type fuels and lubricants. Gasolines containing up to 3 ml TEL per gallon were used in the tests.

To accurately determine just how deposits might increase the octane requirement of an engine, the Petroleum Laboratory studied the most likely contributing factors . . .

VOLUME EFFECT

The volume of the deposit itself actually increases the compression ratio by decreasing the combustion chamber volume. Raising the compression ratio naturally boosts the octane requirement of the engine by increasing the temperature and pressure of combustion chamber gases.

This compression ratio increase is proportional to the amount by which the deposit reduces clearance volume.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Du Pont Research*

So, by measuring the physical volume occupied by deposits, the laboratory was able to calculate the resulting change in compression ratio.

After translating this change into terms of octane requirement, the laboratory found that 20 to 40% of the knocking harm was due to the volume effect of deposits.

CATALYTIC EFFECT

To study the catalytic effect of deposits on combustion reactions, the Du Pont researchers injected finely divided deposits (and their individual constituents) into the combustion chambers of clean engines. Deposits from both leaded and unleaded fuels were used. The variation in knocking tendency caused by the different deposits was then determined.

None of the deposits or their constituents increased the octane requirement. And, surprisingly, some deposit dusts, mainly those from leaded fuels, produced a definite *reduction* in octane requirement. From this, Du Pont has evidence that an increase in knocking tendency is not necessarily due to the catalytic effect of deposits.

THERMAL INSULATING EFFECT

Since any factor which upsets combustion chamber heat balance may affect octane requirement, the thermal insulating effect of deposits was also studied by the Petroleum Laboratory.

As deposit formation progressed in a test engine, the resulting change in heat transferred to the coolant was measured. For comparison, the effect on octane requirement in a clean engine was also obtained . . . by raising the coolant temperature enough to reduce the transfer from the combustion chamber by an equivalent amount.

By comparing these measurements, it was found that the heat insulating effect of deposits could account for a major portion of the increase in octane requirement.

SERVICE TO PETROLEUM AND AUTOMOTIVE ENGINEERS

Results of these studies in booklet form have been made available through the S.A.E. . . . and the Du Pont Petroleum Chemicals Division. If additional copies are required ask your nearest Du Pont district office for the booklet "Possible Mechanisms By Which Combustion Chamber Deposits Accumulate and Influence Knock."

CO-AUTHOR OF PAPER ON GASOLINE STABILITY

RICHARD O. BENDER, Assistant Technical Manager of the Du Pont Petroleum Chemicals Division, is co-author of the paper, "Stability of Present-Day Gasolines," which is described elsewhere in this issue of the Petroleum Chemicals Division *News*.

Previous to his present job, he was in charge of the Chemical Division of the Du Pont Petroleum Laboratory. In this capacity, his activities included development and product application work on additives for gasolines, fuel oils, lube oils and greases.

Before joining the Du Pont Company in 1941, Bender was with the Sinclair Refining Company. He was graduated from Swarthmore College with a B.S. in Chemistry.

RICHARD O. BENDER

Du Pont Historical Highlights

E. I. du Pont, founder of the Du Pont Company, early established a tradition of research by conducting experiments in his kitchen. His unending efforts to improve processes and products irritated one stockholder, who thought the Company should stick to what it had. Eventually, Mr. du Pont bought out the shareholder for about five times his original investment.

Since E. I. du Pont's time, the research activities of the Company have been constantly expanded. And, in addition to the general research carried on at the Du Pont Experimental Station, Du Pont scientists are constantly working on the specialized problems of many individual industries. The deposit studies described in this edition of the Petroleum Chemicals Division *News* are an example of Du Pont's fundamental research on combustion, a field of direct interest to the petroleum and automotive industries.

LITERATURE AVAILABLE

Here is a partial listing of the bulletins, reports, booklets and aids available to you through your Du Pont Petroleum Chemicals Division district office:

Safety for the Small Refinery — A 42-page book on how to set up an effective small refinery safety program . . . . . Serial A-2848

Possible Mechanisms By Which Combustion Chamber Deposits Accumulate and Influence Knock . . . . . Serial A-2087a

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The Month . . .

has said. Suspension of the import duty on lead and accelerated production from domestic mines, hampered last year by labor shortages and strikes, were responsible for the increase. Scrap is also providing a greater supply than a year ago. As a result, the total lead available in the United States may reach as much as 1.3 million tons or about 150,000 tons more than a year ago.

Southwest Research Names Penfold Associate Director

Norman C. Penfold, supervisor of automotive and engine, fuels and lubricants research, has been named an associate director of Southwest Research Institute by Dr. Harold Vagtborg, president of the organization. One of the veteran members of the staff of the four-year old institution, Penfold will retain full supervision of the automotive research laboratories. With the appointment, Dr. Vagtborg also announced that responsibility for active direction of the industrial research laboratories had been assigned to an executive committee comprised of three associate directors.

Shell Development Forms New Level of Management

Establishment of a new level of management at Shell Development Company, Emeryville, Calif., has been announced by Dr. M. E. Spaght, president. The posts have been created to permit the delegation of management authority and responsibility on a basis more consistent with the nature and size of the organization. First promotions to new positions include those naming G. W. Bond, F. R. Brooks, S. Groennings, F. H. Stross, H. A. Cheney, D. D. Davidson, F. D. Moss and J. C. Rapean.

New AIOC "Autofining" Is Desulphurization Process

A new catalytic desulphurization process called "Autofining" has been developed by Anglo-Iranian Oil Company. Operating at low pressure, the new patented process has flexibility for handling a range of different feed stocks. Hydrogen manufacturing facilities are not required, the company stated, and catalyst regenerations are frequent. The "Autofining" process is a result of intensive research and development work and has been fully proved in large pilot plant operations.

Founder of Kellogg Company Dies At New York Home

Morris W. Kellogg, 79, founder and chairman of the board of the M. W. Kellogg Company, died at home in New York in February. A graduate of Stevens Institute of Technology in 1894, Kellogg started the company in 1901 as a small pipe fabricating shop in Jersey City. In late 1944, he sold the company to Pullman Incorporated, becoming a director of the parent corporation. He was president of Kellogg until March, 1946, when he became chairman of the board.

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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Fundamental Physical and Chemical Data

The Vapor Pressure and Critical Constants of Neopentane, JAMES A. BEATTIE, DONALD R. DOUSLIN, AND SAMUEL W. LEVINE. *J. Chem. Phys.*, **19** (1951), pp. 948-9.

The investigators measured the vapor pressure of neopentane in the temperature range from 50° C. to the critical point. An equation is given that represents the data. A study of the compressibility of neopentane in the critical region gives the following values for critical temperature, pressure, volume, and density: $t_c = 160.60 \pm 0.05°$, $p_c = 31.57 \pm 0.03$ normal atmospheres, $V_c = 0.303$ liters per mole, $d_c = 3.30$ moles per liter. It is estimated that the uncertainty in the critical volume and density is approximately 1 percent.

Vapor Pressure of Benzene Above 100° C., PAUL BENDER, GEORGE T. FURUKAWA, AND JOHN R. HYNDMAN. *Ind. Eng Chem.*, **44** (1952), pp. 387-90.

Accurate vapor pressure data for compounds in the high temperature range are relatively few in the literature. The authors report the results of a study of the vapor pressure of benzene in the pressure range of slightly below two atmospheres to the critical point. The critical constants were evaluated by means of compressibility measurements in the critical region. The apparatus and procedure used were tested through measurements on water. The data for benzene converged satisfactorily with the confirmed values at lower pressures. It is estimated that their accuracy is approximately 0.1 percent. The data are reported in tabular and graphical form, and a bibliography of 16 references is included.

2,2,3,3—Tetramethylbutane: Heat Capacity, Heats of Transition, Fusion and Sublimation, Vapor Pressure, Entropy and Thermodynamic Functions, D. W. SCOTT, D. R. DOUSLIN, M. E. GROSS, G. D. OLIVER AND H. M. HUFFMAN. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 883-7.

The thermodynamic properties of 2,2,3,3-tetramethylbutane were studied. The heat capacity of the solid was determined between 12° K. and the melting point, $373.97 \pm 0.05°$ K. The transition temperature ($152.5 \pm 0.2°$ K.), heat of transition (478 cal. per mole), and the heat of fusion (1802 cal. per mole) were determined. The entropy of the solid at 298.16° K. was found to be 65.43 ± 0.15 cal./deg./mol. The vapor pressure was measured between 0 and 65°, and an equation is given to represent the data. The heat of sublimation as calculated from the vapor pressure data is $10{,}365 \pm 50$ cal./mole. The standard entropy of the vapor at 298.16° K. is 93.05 ± 0.3 cal./deg./mole. A vibrational assignment adequate for thermodynamic computations was obtained. The average height of the potential barriers hindering internal rotation that is required to agree with the observed value of the entropy is 4700 cal./mole. Using this value of the average barrier height, the vibrational assignment, and other molecular-structure data, the thermodynamic functions of the compounds were calculated at selected temperatures up to 1500° K.

Heat and Mass Transfer and Pressure Drop In Fluid Flow Through Packed Beds, WALTER BROTZ. *Chem. Ing. Tech.*, **23** (1951), pp. 408-16.

The measurements were made with nitrogen, hydrogen, and carbon dioxide, using glass beads and also catalyst particles of various size ranges. To get accurate results at low gas velocities a special apparatus was used. Data were taken on temperature profiles through the bed. The effective thermal conductivity and the heat-transfer coefficients are presented. The mass transfer experiments were made by observing the mixing coefficients of methylene blue in water flowing over a column of glass beads. Measurements of pressure drop were made on each packed column. The data were correlated, and the results are presented. The mathematical relations derived are summarized. A bibliography of 20 references is included.

The Statistical Thermodynamics of Multicomponent Systems, H. C. LONGUET-HIGGINS. *Proc. Roy. Soc.* (London), **A205** (1951), pp. 247-69.

A new statistical approach to the theory of multicomponent systems is presented. A rigorous calculation of the thermodynamic properties of a conforming solution is possible. Free energy, entropy, and heat and volume of mixing can be related to the thermodynamic properties of the reference substances. The predicted relationships agree well with available data on nonpolar solutions. The theory assumes no lattice or model of the liquid state, and is therefore applicable both to liquids and to imperfect gases, and to two-phase two-component systems near the critical point. The data discussed refer to the substances hydrogen, nitrogen, carbon monoxide, oxygen, methane, ethane, ethylene, nitrous oxide, acetylene, sulfur dioxide, benzene, carbon disulphide, carbon tetrachloride, ammonia, and a few chlor-compounds and alcohols.

Thermal Conductivities of Organic Vapors, J. D. LAMBERT, E. N. STAINES, AND S. D. WOODS. *Proc. Roy. Soc.*, **A200** (1950), pp. 262-71.

Variation of thermal conductivity with pressure was studied for a number of organic vapors at pressures between 50 and 700 mm. and at temperatures of 25°, 66°, and 85° C. Thermal conductivity values are tabulated for air, carbon dioxide, benzene, cyclohexane, hexane, ether, chloroform, ethyl chloride, acetonitrile, acetaldehyde, methyl alcohol, and acetone. The hydrocarbons show comparatively small linear increases, but these become larger as temperature rises. There is no functional relation between the departure from Maxwell's law and gas imperfection as measured by the second virial coefficient.

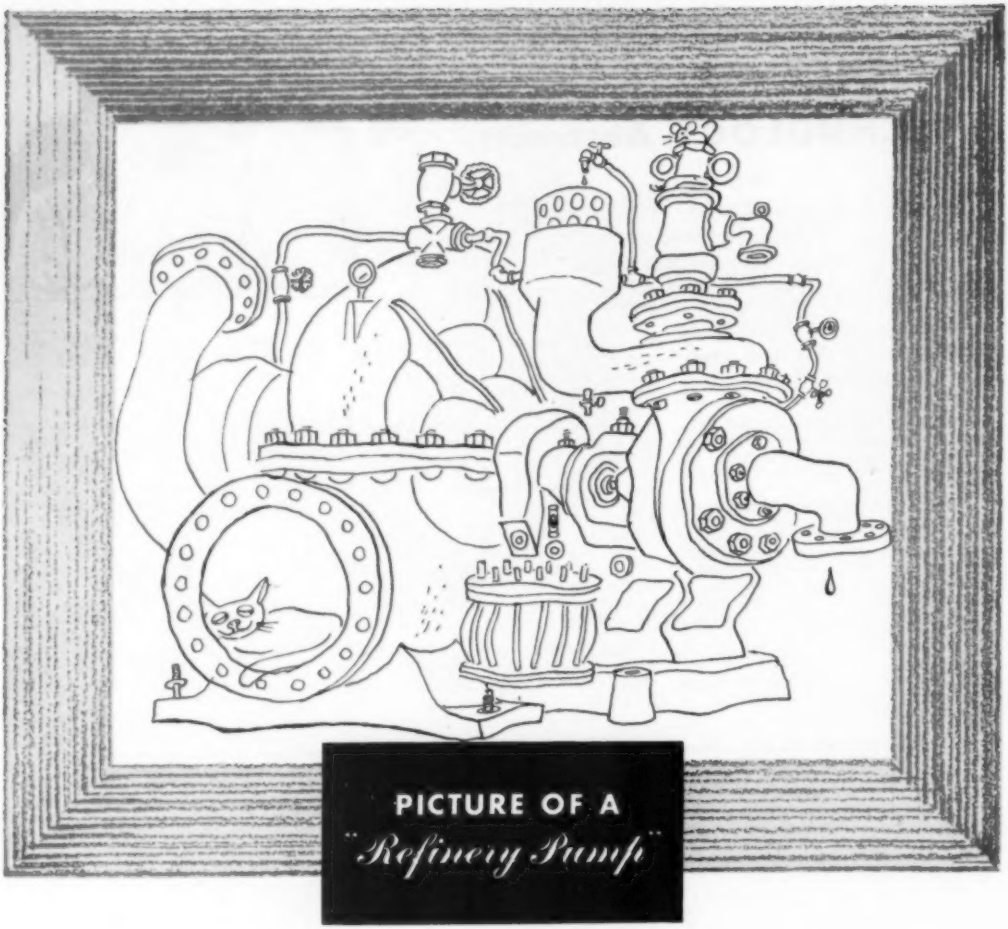
The Viscosities of Organic Vapors, P. M. CRAVEN AND J. D. LAMBERT. *Proc. Roy. Soc.*, **A205** (1951), pp. 439-49.

The viscosities of the vapors of ethane, hexane, cyclohexane, benzene, methyl chloride, ethyl chloride, methyl alcohol, methyl ether, acetaldehyde, acetone, and acetonitrile were determined at temperatures 35°, 50°, 65°, and 78° C. and pressures of one to two cm. The procedure used was the observation of the damping of a pendulum swinging in the vapor. It was found that the relationship between viscosity and temperature was linear. The apparatus and procedure is described in some detail and theoretical implications of the observations are discussed.

Adsorption Isotherms for Pure Hydrocarbons. ROBERT A. KOBLE AND THOMAS E. CORRIGAN. *Ind. Eng. Chem.*, **44** (1952), pp. 383-7.

An adsorption isotherm, similar to that of Langmuir and previously proposed but never tested, appears to the authors to have advantages over the

THESE abstracts are selected from the current literature of science and technology, not including trade journals easily available. Photostatic copies of original articles can be obtained at nominal cost from The Library of Congress, Photoduplication Service, Washington 25, D. C. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript will be prepared and furnished by arrangement with The Leslie Laboratories.



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Langmuir and Freundlich equations. This isotherm was tested using data from the literature for the adsorption of hydrocarbons on activated charcoal. These data cover a wide range of temperature and pressure. The isotherm was found to apply over a wide range of conditions, and it was felt that it offers a safer means of extrapolating adsorption data than the older equations.

Solubility of Polyindene in Paraffin Hydrocarbons. P. O. Powers. *Ind. Eng. Chem.*, **44** (1952), pp. 380-2.

The investigation was made in order to provide a model of the solubility behavior of coal tar hydrocarbon resins in solvents or in plasticizers. It was believed that the behavior of fractions of polyindene in *n*-alkanes would provide such a model system. Polyindene material was fractionated and the solubility of fractions of varying molecular weight was determined in *n*-decane, *n*-dodecane, *n*-tetradecane, *n*-hexadecane, and *n*-octadecane. Each of the fractions showed limited solubility in all solvents and the solubility decreased with increase of molecular weight of the solvents and of the resin fractions. The data are presented in tabular and graphical form, and a diagram is given showing the probable solubility of polyindene. A bibliography of 10 references is included.

Chemical Composition and Reactions

Kinetics of the Thermal Decomposition of Olefins. I. Propylene. K. U. Ingold and F. J. Stubbs. *J. Chem. Soc* (1951), pp. 1749-55.

It is stated that the thermal decomposition of propane in a static system and within the pressure range 50-500 mm. of Hg and the temperature range 570-650° C., is a homogeneous first order reaction with an activation energy of 57.1 kcal./mole. For the first half of the reaction the observed pressure increase is a direct measure of the propane decomposed. The products are largely methane, ethylene and hydrogen, along with a condensible intermediate that decomposes and carbon. Below a temperature of 570° C. polymerization occurs along with decomposition. The chemical reactions involved are outlined and discussed.

Catalyzed Reactions of Unsaturated Hydrocarbons with Hydrogen and Deuterium. T. I. Taylor and V. H. Dibeler. *J. Phys. & Colloid Chem.*, **55** (1951), pp. 1036-65.

The authors discuss the Ni-catalyzed hydrogenation, isomerization, and D exchange of the butenes. In the experimental work reported the emphasis was upon the butene molecules themselves rather than other phases. 2-butene of 99 percent purity and 85 percent cisisomer was used. The catalyst was nickel wire activated by a special procedure which is described. Analyses were made by use of the mass spectrometer and also the infrared spectrometer. It was found that hydrogen or deuterium was required for the double-bond migration of 1-butene. The results of the work are reported in considerable detail. In conclusion, the

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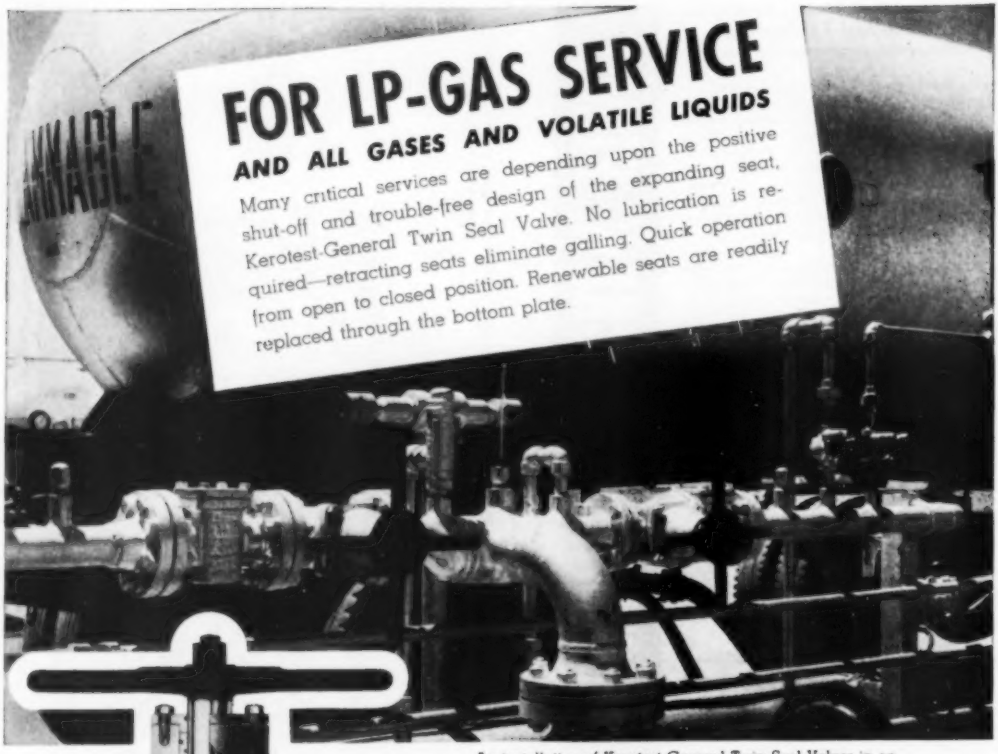

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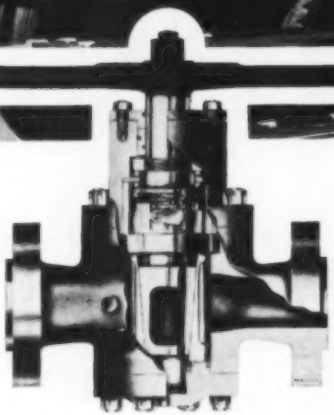

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authors believe that none of the formulations reviewed in the beginning of the article were entirely supported by the results. In fact, several of the observations could be accounted for on the basis of more than one of the postulations.

Catalytic Cracking of Rosin, IRA T. CLARK AND ELWIN E. HARRIS. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 1030-2.

Rosin was cracked over silica-zirconia-alumina catalyst and was found to yield lower molecular weight compounds, largely aromatic hydrocarbons. The proportion of aromatics in the oil products increased with temperature until 100 percent aromatics was reached at 450° to 500° C. The total yield of oil products decreased with increase of temperature. Five to seven percent of the product obtained was composed of phenols or organic acids. The remainder was aromatic hydrocarbons with some naphthenes and hydroaromatic compounds. Among the compounds shown to be present were methylcyclopentane, dimethylcyclopentanes, benzene, toluene, xylenes, diethylbenzenes, trimethylbenzenes, naphthalene, methyl- and dimethylnaphthalenes, and anthracene. Cracking was effected at atmospheric pressure by dropping a regulated flow of melted rosin at 180° C. directly upon the pelletted catalyst that had previously been heated to the reaction temperature. The properties of the hydrocarbons separated are given.

Studies of the Fischer-Tropsch Synthesis. XII. Composition Changes of Nitrided Iron Catalysts During the Synthesis, J. F. SCHULTZ, B. SELIGMAN, J. LECKY AND R. B. ANDERSON. *Jour. Am. Chem. Soc.*, **74** (1952), pp. 637-40.

The paper deals with the changes in the composition of nitrided iron catalysts during the synthesis. These catalysts oxidize at a much slower rate that reduced catalysts under corresponding conditions. Nitrided catalysts are more active, in many cases, than the reduced catalysts, and yield a product of lower molecular weight containing a higher percentage of oxygenated compounds. The operating pressures used in the synthesis were 7.8 and 21.4 atmospheres. Nitrides are slowly converted to carbonitrides; the rate of replacement of nitrogen by carbon was found to be somewhat more rapid at 21.4 than at 7.8 atmospheres. At the higher pressure, the type of structural promoter appears to be important in determining the rate of oxidation and deposition of free carbon. When spent nitrited catalyst is treated with hydrogen, the nitrogen is removed whereas the carbon is not greatly changed. Part of the carbon appears either as Hagg carbide or as cementite depending upon the temperature of hydrogenation.

Electrolytic Production of gem-Dinitroparaffins, CARL T. BAHNER. *Ind. Eng. Chem.*, **44** (1952), pp. 317-18.

The cetane numbers of Diesel fuels were found to be increased by the addition of dinitroparaffins. The cetane number of the base fuel was 41.2 and that of various blends ranged from 43.3 up to 48.1. The article is mainly concerned with the production of the polynitroparaffins by the electrolysis of solutions of the nitroparaffins. It was found that a solution of alkali metal salts of nitro-

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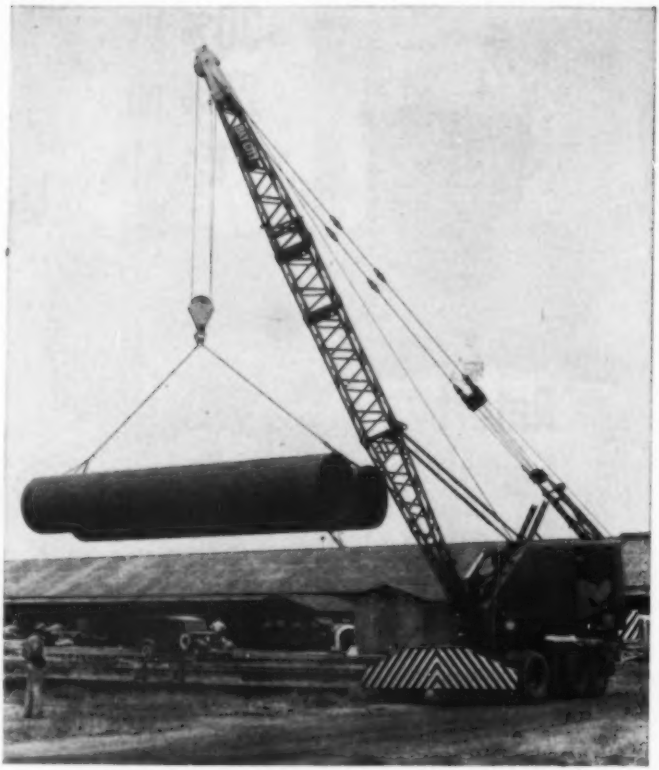

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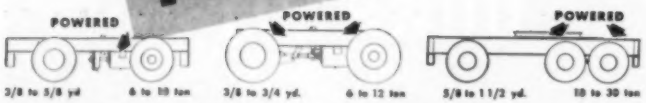

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paraffin and inorganic nitrates yielded dinitroparaffins.

Manufacture: Processes and Plant

The Effect of Pulsations on Heat Transfer. Turbulent Flow of Water Inside Tubes, FRANK B. WEST AND ALLAN T. TAYLOR. *Chem. Eng. Progress,* **48** (1952), pp. 39-43.

The investigation was concerned with the effect of pulsations in the flow rate on the rate of heat transfer in heat-exchanger tubes. Pulsations of this type can be produced easily by reciprocating pumps. Many heat exchangers are subjected to pulsating flow already, or could easily be so subjected by altering the air chambers commonly used to dampen the pulsations of reciprocating pumps. Water film coefficients of heat transfer inside tubes for heating and cooling at Reynolds numbers of 30,000 to 85,000 were increased as much as 60 to 70 percent by the use of partially dampened pulsating flow. There is an optimum degree of pulsing, since it was found that severer pulsations were not as efficient as lesser ones and resulted in more vibration than moderate pulsations. The increase in power consumption was no more than 30 percent at the region of optimum pulsation. It appears that the procedure should have applications in new design and also in increasing the capacity of existing heat exchangers. The data are presented in some detail, and a bibliography of 13 references is included.

Performance of a Packed Liquid-Liquid Extraction Column Under Controlled Agitation, GEORGE FEICK AND HARRY M. ANDERSON. *Ind. Eng. Chem.,* **44** (1952), pp. 404-9.

The authors briefly review the types of equipment and procedure that have been used for liquid-liquid extraction. Extraction columns are generally less efficient than those used for contacting a liquid with a vapor or gas because of the less effective dispersion in mixing of the fluid streams when both of these streams are liquid. In order to improve the dispersion of the liquid without interfering with the countercurrent action of the column, a column was built in which provision was made to provide energy for agitation through the vertical reciprocating movement of the liquids with respect to the packing. The column was tested using the system benzoic acid-toluene-water. The extraction coefficient was greatly increased through agitation and the HTU was decreased. In some instances, the increase in the extraction coefficient was 500 percent or more. Similar results were obtained in extracting acetic acid from toluene with water. The authors conclude that columns of this type may become competitive with existing forms of commercial extraction equipment.

Producing Fuel Oil From Coal. E. L. CLARK, R. W. HITESHUE, AND H. J. KANDINER. *Chem. Eng. Progress,* **48** (1952), pp. 15-20.

Coal is normally converted into oil by a two-step process. First, a hydrogenation to liquefy the coal to heavy oil,

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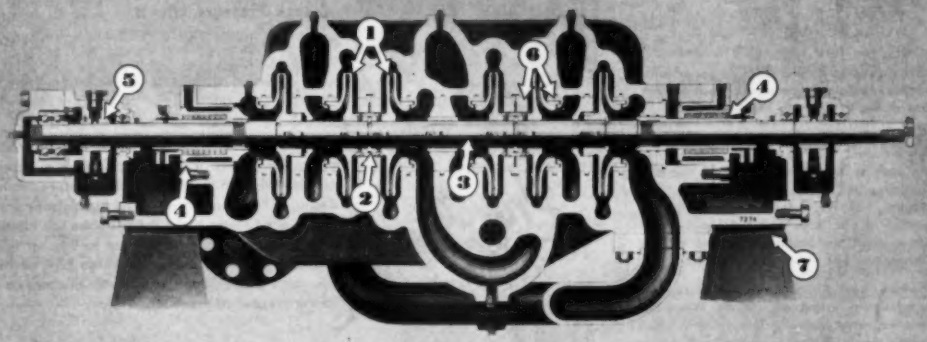

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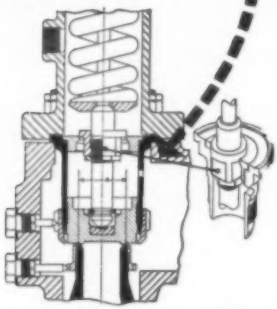


Fig. 1 Fig. 2

When a standard relief valve on gas or vapor service is installed, where back pressure exists, one of two undesirable effects will occur:

Constant Back Pressure — The back pressure acts on part of the upper and the overhanging part of the lower surface of the disc, cancelling out the back pressure force. There remains, however, a force acting on the top portion of disc (area A) which increases the spring load and causes the valve to pop "heavy."

Variable Back Pressure can not be compensated for by spring adjustments. When one or more valves discharge into a common flare header, variable back pressure is placed on the remaining closed valves. This can create a hazardous condition on remaining closed valves, by adding to the spring force. The valve then is prevented from opening until pressure has risen far above the vessel design limit.

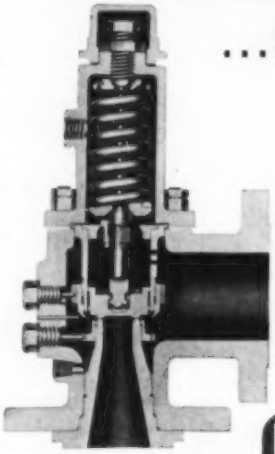
[redacted] is a simple, foolproof method of nullifying these undesirable effects (see Figure 1 above).

Operation — Crosby achieves *Stable Popping Pressure* by the addition of a piston affixed to the spindle, of area proportioned to equal the unbalanced area of the disc (area A in Fig. 1). Back pressure introduced through the port in the guide then acts on two equal areas in opposite directions, and cancels itself out, neither aiding nor opposing the spring.

To assure full lift and stability, a vent system (see sectional view of piston, Fig. 2) is employed. When the valve is open, the flats on the piston will vent any accumulated back pressure that would tend to close the valve. The adjustment and operating characteristics are similar to the conventional valve. The actual flow into the bonnet is relatively low and can be vented to atmosphere, or through a properly sized discharge header.

Extensive, trouble-free use in the field has proved the success of this Crosby Balanced Area Design.

Here's the [redacted] RELIEF VALVE which eliminates back pressure effects ...and reduces costs!



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On the many installations where Crosby JO-BP Valves have been in operation, refineries report sizable savings in piping costs. The reason—smaller discharge lines made possible by higher back pressure. Since Crosby JO-BP Relief Valves will handle back pressure surges ranging up to 90% of inlet pressure, smaller diameter discharge pipe carries the same amount over the same distance that formerly required much larger pipe.

Proved PROTECTION!

On-the-job performance of Crosby JO-BP Relief Valves proves that you can depend on the vented Balanced Area Design to operate on the set pressure. Thus you are assured of a *Stable Popping Point*. What's more, a full lift is obtained over the normal range of back pressures. The Crosby JO-BP operates with an unrestricted nozzle, follows standard nozzle flow equations for above or below critical ratio as the case may be. With its vented Balanced Area Design, the Crosby JO-BP provides a foolproof, time-tested method of eliminating back pressure effects.

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and, second, a further hydrogenation of this oil to reduce its molecular weight and to obtain gasoline and other liquid fuels. The authors report a series of pilot plant studies of the conversion of a Wyoming coal into fuel oil at an operating pressure of 1500 psi. This is a low pressure when compared to the 4000 to 10,000 psi normally used in European industrial coal-hydrogenation plants. Impregnation of the catalyst on the coal surface greatly increases the activity of certain hydrogenation catalysts. This has resulted in the decreased hydrogen pressure necessary for the liquefaction of the coal. Yields equivalent to three barrels of fuel oil and 3500 cubic feet of hydrocarbon gas per ton of Rock Springs Wyoming coal were obtained in a continuous pilot plant. A flow diagram of this plant is presented, together with a tabular and graphical summary of the data.

The Expansion of Vertical Cylinders Under Liquid Head, PETER KERR. *Jour. Inst. of Petroleum,* **37** (1951), pp. 740-8.

The smaller the diameter and height of a tank, and the thicker its plates, the less it expands. A simple criterior is useful in deciding whether expansion is worth consideration or not. An equation is given that can be used. The sides of a vertical cylinder are pressed outwards when the tank is filled with liquid, and so they expand, thus increasing the capacity of the tank. For small tanks the effect is negligible. For an eight-ring API 168-foot tank, expansion is slightly less than 0.08 percent.

Products: Properties, Utilization and Analysis

Aviation Gasoline and Its Component Hydrocarbons: Wartime Research (1940-1945). H. M. SMITH, A. J. KRAEMER, AND H. M. THORNE. *U. S. Bureau of Mines (1951) Bulletin 497.*

This report of the Bureau of Mines summarizes data obtained in research on aviation gasoline in the period 1940 to 1945. Surveys were made of the crude oils and condensates suitable for aviation gasoline for blending to make high octane products. The subjects of desulfurization and superfractionation to utilize marginal stocks are considered. Data on the losses of aviation gasolines by evaporation are given.

Influence of Carbon Disulphide on Octane Number and Lead Susceptibility, GEO. E. MAPSTONE AND J. S. DURHAM. *Jour. Inst. of Petroleum,* **37** (1951), pp. 737-9.

There are few data on the presence of carbon disulfide in crude oil or straight-run gasolines. It can be formed during cracking if free sulfur is present. It is a normal component of benzol, which is frequently blended with gasoline, and has also been identified in shale gasoline. The loss in lead efficiency rises rapidly as the percent of carbon disulfide increases from 0 to 0.2 percent and increases little thereafter as the percent of carbon disulfide increases up to one percent. The losses in lead efficiency range from 0 to 87 percent. The studies were made using a reference fuel composed of 60 percent iso-octane and 40

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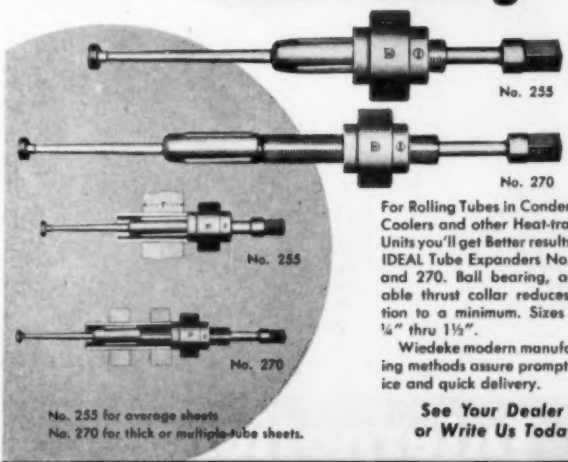

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percent n-heptane, to which we added varying quantities of freshly distilled carbon disulfide. The octane numbers were determined by the Motor Method, clear and leaded. A bibliography of six references is included.

Aggregate Packing in Bitumen Macadam Carpets. J. F. T. Blott. *Jour. of Applied Chem.*, **1** (1951), pp. S152-9.

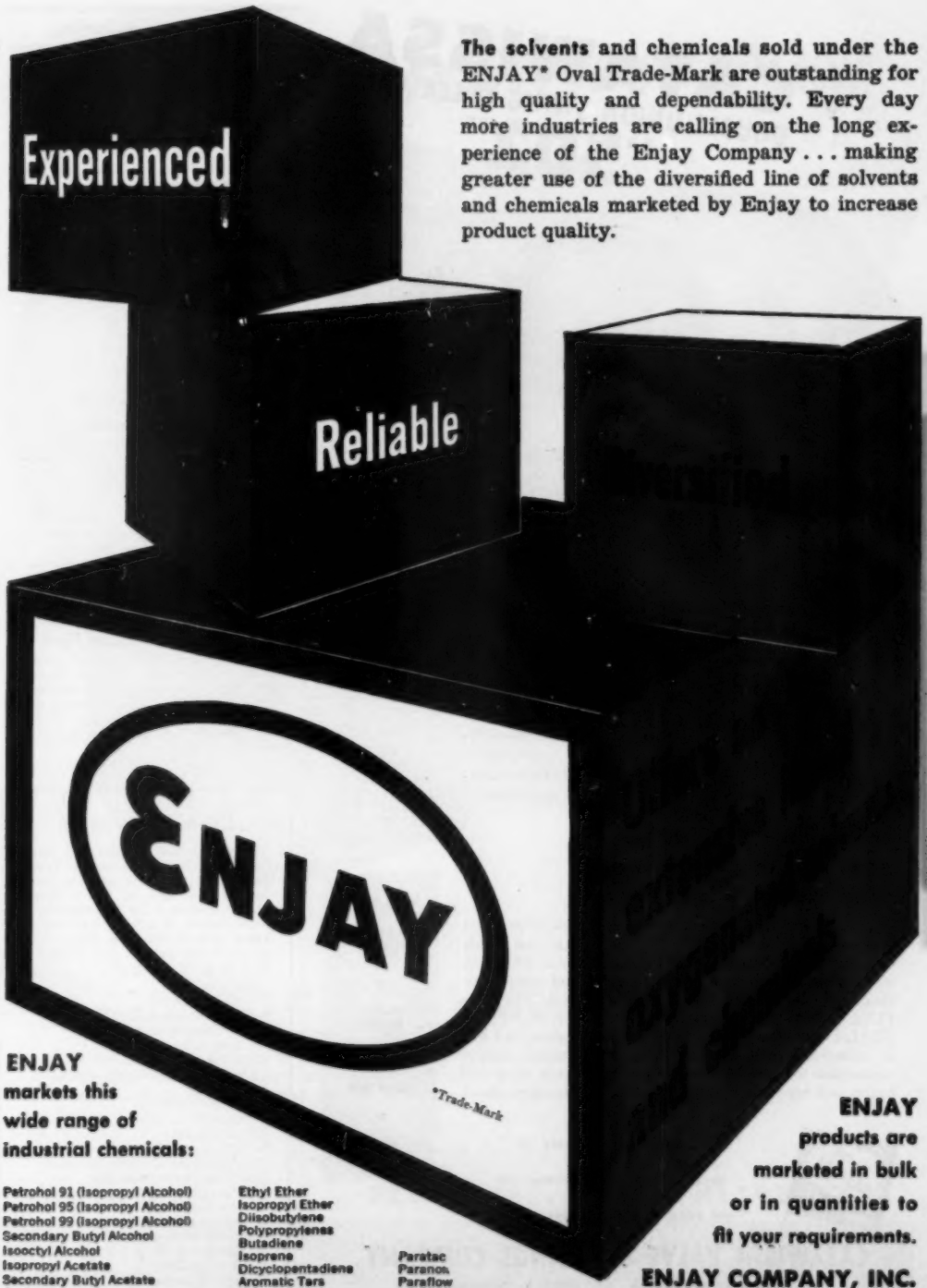
The object of the work was to consider the theoretical packing of uniform spheres in layers, with the idea that the relationship derived might apply in principle to the packing of the stone aggregate in road carpets. The closeness of packing obtained in the initial compaction by rolling will determine whether further compaction can occur under traffic, thus leading to the possibilities of fatting-up owing to the reduction in voids content and the development of corrugations owing to differential consolidation. The major object in the construction of any type of flexible carpet or foundation is to reach minimum voids content in the compacted layer, since this results in the most stable structure. It is known that when the sizes of the pieces do not differ by more than a factor of two or three the maximum packing in bulk of a mixture of such sizes is little different from that of the individual faction of uniform size. Also the packing in bulk of angular particles of uniform size does not differ appreciably from that obtained with uniform spherical particles. Theoretical relationships are derived for the packing of uniform spheres in horizontal layers and in thicknesses ranging from that equal to the diameter of the individual sphere to relatively great thicknesses. It is concluded that the mechanical properties of the carpets may depend critically on the rate of spread of the material and that the rate of spread may pass through a series of optimum values as the thickness of the carpet relative to the size of the aggregate increases.

Distillation. Arthur Rose. *Analytical Chem.*, **24** (1952), pp. 60-4.

This review of analytical distillation is one of a series of articles in the Fourth Annual Review of Analytical Chemistry. Topics considered include: General apparatus, vacuum and micro distillation apparatus, specialized distillation apparatus, column accessories, column test mixtures, column evaluation and operating variables, a review of other reviews and books, new applications of distillation in analysis, low temperature distillation, analysis of petroleum and petroleum fractions, and analysis of synthetic fuels and by-products from coal and shale. A valuable bibliography of 151 references is included.

A Vibrating-plate Viscometer. J. G. Woodward. *J. Colloid Sci.*, **6** (1951), pp. 481-91.

A new viscometer is described which is characterized by direct, almost instantaneous measurements, and which is amendable to application in continuous or automatic recordings covering a range of 0.1 to 100,000 centipoises with a single instrument. It can measure the viscosity of samples of 0.5 ml. to infinity. Cleaning of the apparatus between samples is easy. Temperature range can be



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from very low temperature to 100° C. The accuracy is ±5 percent in an isolated test, but is better when similar liquids are compared. The instrument comprises a thin circular plate 0.2 inches in diameter and 0.01 inch thick, mounted on a steel reed so that it will vibrate at its mechanical resonance by an electromagnetic motivating system. The amplitude of motion of the disc is determined by the viscous damping of the fluid surrounding the plate. The amplitude is measured by means of piezoelectric blocks mounted on opposite sides of the disc's face and generating a voltage proportional to the amplitude. The amplitude itself is proportional to the product of the viscosity and density of the fluid, and hence the voltage scale can be calibrated in terms of this product.

Socony-Vacuum Presents Largest Employe Award

An award of $2,863, largest yet made to an employe under Socony-Vacuum Oil Company's ("Suggestion System"), has been won by Peter G. Kercher, a foreman in the welding department of the company's refinery at Casper, Wyo. He won the award after suggesting a method for preventing the loss of the bead catalyst used in the refining of petroleum products.

SW Gas Measurements Groups Complete Short Course Plan

The executive and general committees of the Southwestern Gas Measurements Short Course, recently completed plans for the 1952 Short Course, which is to be held at the University of Oklahoma, North Campus, Norman, Okla. May 27, 28, 29.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

N,N,N′,N′-Tetraethyl-m-phenylene diamine
Tetraallyl silane
0,3,3-Bicyclooctane
o-tert.-Butyl toluene
Cyclobutane
1,1,3-Trichloroacetone
2-Hydroxy-6-methyl terephthalic acid
Ethyl vinyl ketone
Propylene tetramer
Ethacrylic acid
9-Anthraldehyde
4,5-Dihydroxy-2-methylpyridine
5,14-Dimethyloctadecane
1,4-Pentadiene
Triacontane
Cyclobutyl carbinol
Fluorodiiodomethane
N-Vinylpiperidine
Dodecyl gallate
Dioctyl thioether

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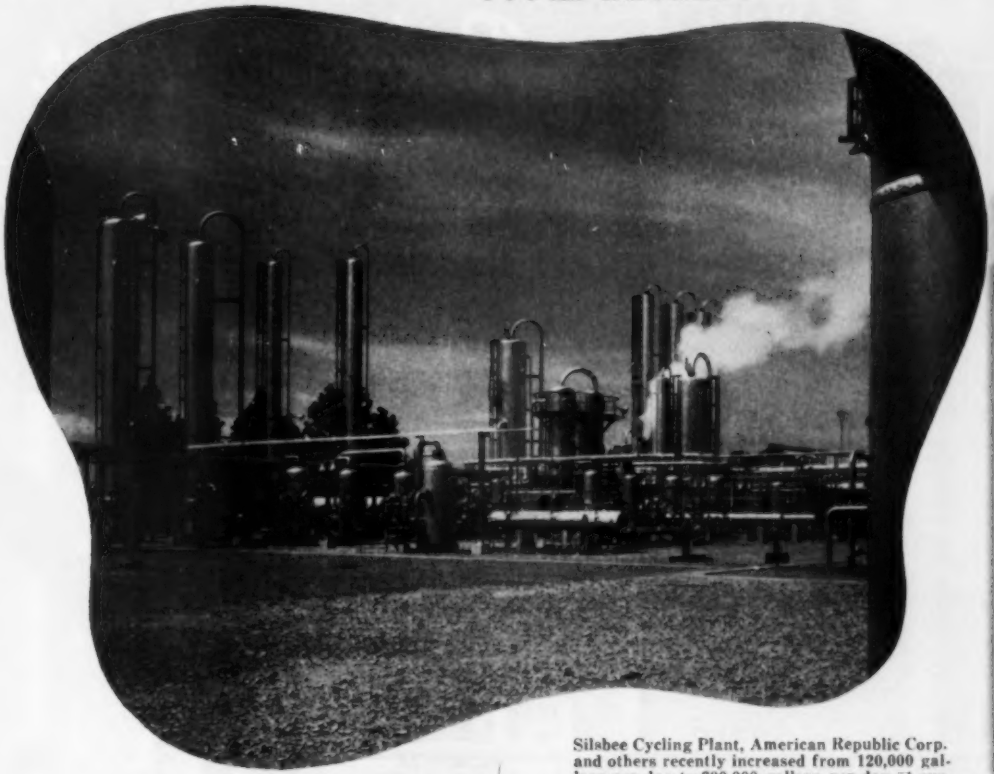

Silsbee Cycling Plant, American Republic Corp. and others recently increased from 120,000 gallons per day to 200,000 gallons per day at surprisingly low cost per gallon for additional output.

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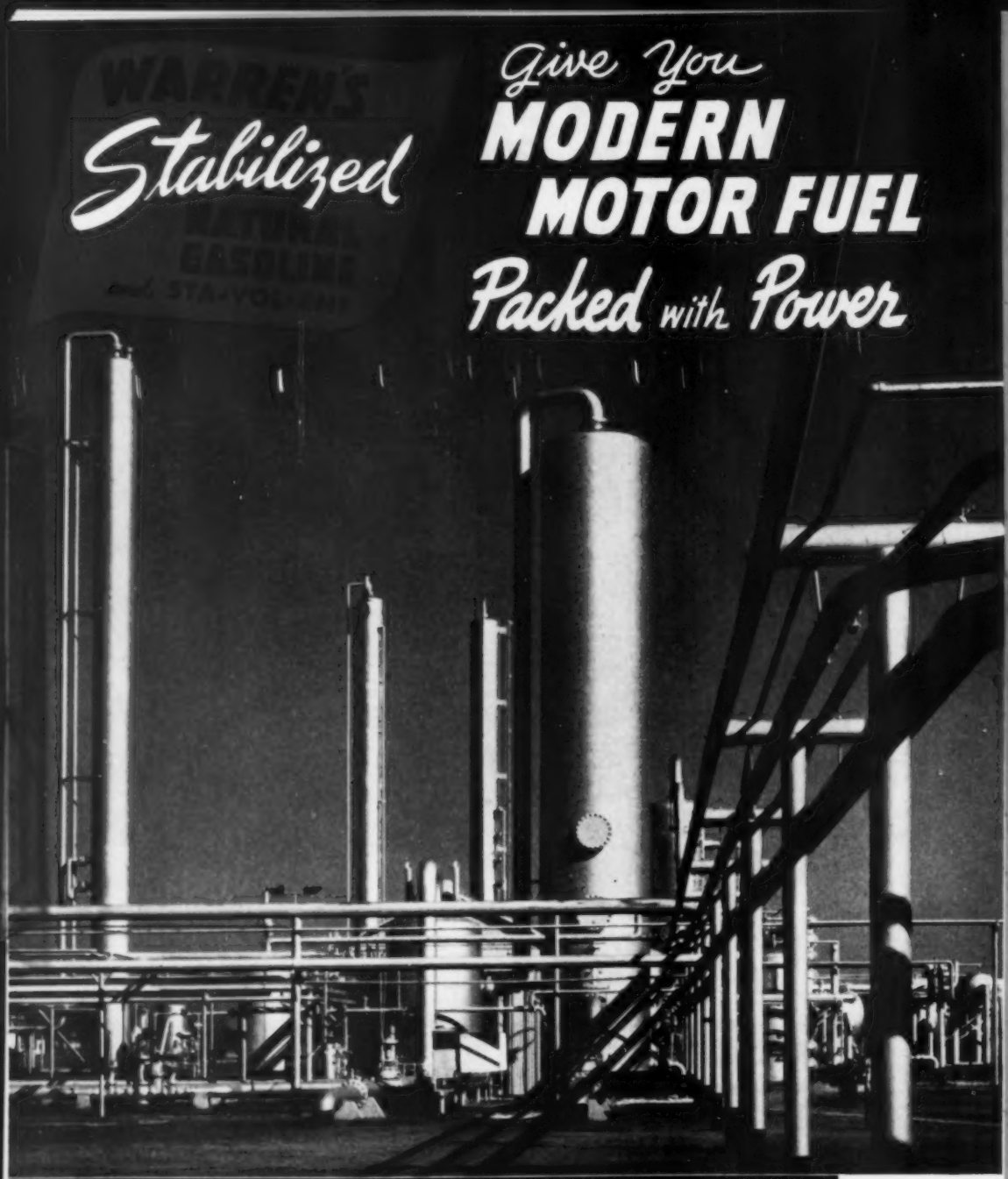

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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by DR. HEINZ HEINEMANN

(From the Official Gazette, January 29, February 5, 12 and 19, 1952)

REFINING

U.S.P. 2,583,554. Method for the Separation of Alpha-Methyl Naphthalene from Beta-Methyl Naphthalene by Azeotropic Distillation. J. Feldman and M. Orchin to the U.S. Secretary of the Interior.

Mixtures of alpha- and beta- methyl naphthalene are separated from another by adding undecanol to the mixture which is then distilled at a subatmospheric pressure selected so that the undecanol forms an azeotrope with beta-methyl naphthalene, e.g. at a pressure of 200-300 mm. Hg.

U.S.P. 2,584,296. Process for Countercurrent Contacting of Solids and Gases. H. W. Scheeline to Standard Oil Development Company.

In the contacting of solids and gases or vapors, particularly in treating hydrocarbon gases or vapors with granular activated charcoal for concentrating a hydrocarbon fraction, the granular solids are passed downwardly in non-vibratory motion through a gas treating zone countercurrent to a rising gas or vapor stream and in vibratory motion downwardly through a connecting zone countercurrent to a gas or vapor stream flowing upwardly at a higher velocity than in the gas treating zone to transfer heat by indirect heat exchange in the second zone.

U.S.P. 2,584,785. Process and Apparatus for Separation of Mixtures. J. R. Bowman and M. T. Cichelli to Gulf Research and Development Company.

In partially separating gas mixtures, such as those of natural gas, natural gasoline from casinghead gas, and the like, an unobstructed flow of vapor, such as steam, is established through a separating zone. The gas mixture is distributed in this zone. Part of the vapor is removed by causing it to undergo a change of phase in a region of removal within this zone. A concentration gradient is established thereby in this zone, and at least two streams of different compositions are withdrawn therefrom at different distances from the region of removal.

U.S.P. 2,584,861. Method of Separating Organic Carboxylic Acids from Hydrocarbon Oil Compositions. P. J. Garner and B. J. Donovan to Shell Development Company.

Oil Soluble fatty acids, such as naphthenic acids, are separated from their solution in a hydrocarbon oil composition by contacting this composition with an inorganic copper compound or the like, and a water-soluble alkanolamine in the presence of an aqueous alcoholic solution. An aqueous alcoholic solution of a water-soluble complex copper alkanolamine fatty acid salt is thus formed and is separated.

U.S.P. 2,584,875. Solid Acetylene. R. L. Hasche.

Compressed acetylene is encased in solid carbon dioxide to form a solid acetylene composite which may have the shape of a briquet.

U.S.P. 2,585,490-2. Continuous Adsorption Process. J. L. Olsen to Sun Oil Company.

Details are claimed of continuous processes for separating a liquid charge mixture of organic materials of different adsorbabilities, such as a petroleum charge composed of aromatic or olefinic and saturated hydrocarbons. The adsorbent is continuously passed through a separating zone in the form of a moving bed, or through a series of separate contact zones and then through a separating zone. Silica gel may be used as the adsorbent.

U.S.P. 2,585,525. Separation of Xylene. W. F. Yates to Monsanto Chemical Company.

Technical xylene is partially sulfonated. Unsulfonated oil is removed. The sulfonated residue is fractionally hydrolyzed at a temperature of up to 120°C. The hydrolyzed fraction is combined with the unsulfonated oil, and the resulting mixture is then completely sulfonated and fractionally hydrolyzed thereafter. A predominantly p-xylene containing fraction is obtained.

U.S.P. 2,585,652. Anion Exchange Resins and Method of Treating Mineral Oils. H. D. Hartough, P. D. Caesar, and S. J. Lukasiewicz to Socony-Vacuum Oil Company, Inc.

A mineral oil fraction containing acidic constituents is contacted with a nitrogenous resinous material of a mole weight of at least 500, and the treated mineral oil is then separated from the residuous material which retains the acidic constituents. The resinous material used is obtained by reacting thiophene with formaldehyde or a reversible polymer thereof, and a depolymerizer for this polymer.

U.S.P. 2,586,660. Leaded Fuel Composition. W. G. Howell, Jr., to Standard Oil Development Company.

A leaded gasoline fuel contains 0.5-1 times the quantity of a halogenated hydrocarbon scavenging agent required to stoichiometrically react with the lead and a volatile alkyl tin compound in a proportion sufficient to provide 0.5-1.5 atoms of tin per atom of lead.

U.S.P. 2,586,703. Shale Distillation. W. W. Odell to Standard Oil Development Company.

Details are claimed of a process of producing hydrocarbons from bituminous materials, such as oil shale, tar sands, coal, and the like, by pre-heating and distilling these materials at carbonization temperature in the form of subdivided fluidized solids.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,583,619. Preparation of a Raney Catalyst Surface. P. C. White to Standard Oil Company (Indiana).

An iron wall in the conversion zone of a CO/H_2 synthesis gas mixture is alloyed to a thickness of 0.015-0.125 inch with 35-65 per cent by weight of zinc to form an integrally bonded alloy layer on the surface of the wall. This layer is leached with an aqueous solvent which will dissolve the zinc but not the iron. The catalytic iron is thereby left in the form of a fixed skeleton layer on the metal wall. The skeleton layer is then activated by treatment with hydrogen.

U.S.P. 2,584,102. Supported Phosphoric Acid Catalyst and its Preparation. J. M. Mavity to Universal Oil Products Company.

A solid catalytic material useful in olefin polymerizations is formed by treating a precalcined composite of a phosphoric acid and a solid supporting material with PCl_5 $POCl_3$, or PCl_3. The treated composite is calcined at a temperature of 100-550° C.

U.S.P. 2,584,148. Production of a Catalyst from Clay. G. A. Mills to Houdry Process Corporation.

Raw kaolin is treated with mineral acid at elevated temperature for a time sufficient to increase its activity. Adhering water and water soluble substances are removed, and the thus purified kaolin is dried, formed to pellets and treated at a temperature above

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500° F. The pellets are then contacted with an Al-salt solution. Hydrocarbon conversion catalysts are obtained.

U.S.P. 2,584,286. Preparation and Drying of Catalytic Hydrogel Beads. J. A. Pierce and C. N. Kimberlin, Jr., to Standard Oil Development Company.

Dry adsorbent inorganic gels in spherical form are prepared by emulsifying a sol of the gel-forming substance in the form of minute droplets in a water-immiscible liquid, maintaining the emulsion at a temperature of 150-200° F. to cause conversion of the sol particles to hydrogel and maintaining the hydrogel particles in said liquid under the same conditions for a period of time sufficient to remove at least 50 percent water and to convert the hydrogel into hard and gritty gel spheres.

U.S.P. 2,584,405. Preparation of Silica-Boria Catalysts Containing Alumina or Magnesia. J. P. West to Universal Oil Products Company.

A metathesis reaction is effected between an alkyl-ortho-silicate, a boric acid ester and an Al or Mg salt (or both) of an organic oxygen containing radical at a temperature of at least 150° C. but below the normal decomposition point of the salt. A hydrocarbon conversion catlyst is obtained.

U.S.P. 2,585,033. Reactivation of a Dehydrogenation Catlyst. E. W. Pitzer to Phillips Petroleum Company.

A paraffin dehydrogenation catalyst comprising a difficulty reducible heavy metal oxide supported on a relatively inert supporting material, e.g. Cr_2O_3 on alumina, and spent by alternate dehydrogenation and regeneration operations is ground. The ground catalyst is digested with liquid concentrated nitric acid. The resulting mixture is evaporated to dryness. The residue is heated to decompose the nitrate formed. The residue is comminuted, mixed with volatile organic binder, shaped into uniform bodies and ignited to remove the binder.

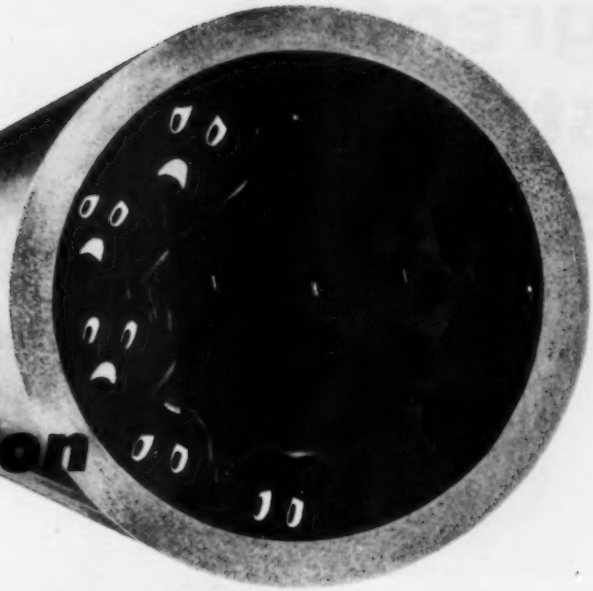
U.S.P. 2,585,454. Preparation of a Sulfur-Containing Activated Carbon. B. W. Gamson to Great Lakes Carbon Corporation.

An activated carbonaceous body, useful for catalytic reactions, decolorizing of mineral oils, and the like, is produced by forming a mixture of a heavy hydrocarbonaceous substance boiling above 350° F., e.g. a petroleum residue, with elemental sulphur in an amount constituting at least 60 percent the stoichiometric equivalent of the four —12 percent hydrogen content of said substance. The mixture is heated to produce a hard, infusible and insoluble solid which is then heated in a mild oxidizing atmosphere.

U.S.P. 2,586,323. Inhibiting Corrosion of Aluminum Chloride-Hydrocarbon Complex Liquid in Presence of HCl Promoter with Iodine Compounds. W. F. Glassmire and W. R. Smith to The Texas Company.

A hydrocarbon conversion catlyst comprising an Al Cl_3-hydrocarbon complex liquid and HCl promoter has in-

No coke is safe from this combination



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There's the simplest, most efficient combination for opening coke-clogged still tubes fast. Keen, long-lasting teeth on the cutter head unlock the iron grip of coke deposits, smash their way through clogged tubes without cutting tooth design in tube walls. And giving the proper spin in this combination is the powerful Lagonda 1100 Series motor. Ball thrust bearings at both front and rear plus exclusive Lagonda pressure lubrication insure long life and a short clean-out job. It will pay you to remember the combination that cuts down-time — clears coke deposits in no time ... Lagonda 1100 Series tube cleaners. And you'll find a Lagonda man is a "savvy" partner on your next coke-busting job. Call him, he'll be happy to help.

BULLETIN Y-29 ...
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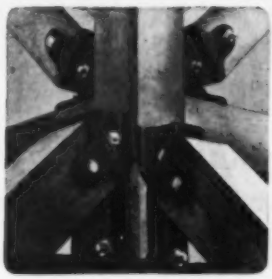

By use of WCEC connectors, the struts develop their strength as a column by direct bearing on the square end of the strut against a cast iron seat. The connectors spread the horizontal component of the stress in the strut over a large area of the vertical columns, to assure that the allowable resistance of the wood in compression perpendicular to the grain will not be exceeded. The vertical component of the stress is transferred to the vertical column in direct end grain bearing, through shear bars on the timber connector. These patented connectors develop the greatest structural strength of the timber joints, an accomplishment almost impossible to achieve by bolting alone. WCEC cooling towers directly in the path of hurricanes have withstood the test of extreme wind load without damage.

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TOWERS OF STRENGTH WCEC

Typical installation at Bloomingdale's, New York City. Other WCEC towers at Gimbel Brothers, Pittsburgh; Scruggs-Vandervoort-Barney, St. Louis; Sears-Roebuck, Chicago; J. C. Penney Co., St. Louis.

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corporated therein 0.2-2.0 percent by weight of iodine, HI, or hydrocarbon iodides. This additive inhibits attack of the catlyst liquid on ferrous metal surfaces during conversion reactions.

CRACKING AND REFORMING

U.S.P. 2,584,756. Catalysis and Process for Reforming Hydrocarbons. H. M. Stine to Socony-Vacuum Oil Company, Inc.

A hydrocarbon reforming catalyst consists of 10 percent beryllium oxide, 10 percent ferric oxide, and 80 percent aluminum oxide in the form which results from heating a mixture of these oxides at a temperature of 1150-1500° F. The content of aromatics and unsaturates in a hydrocarbon mixture is increased by reforming in the presence of this catalyst.

U.S.P. 2,585,737. Catalytic Reforming process. C. L. R. Carpenter to Standard Oil Development Company.

A CO/H_2 gas mixture is continuously produced from normally gaseous hydrocarbon in the presence of a catalyst comprising an eighth group metal at a temperature of 1300-2000° F. in a process, details of which are claimed.

U.S.P. 2,586,705. Means for Distributing Solids in Gases in Catalytic Apparatus. J. S. Palmer to Standard Oil Development Company.

A catalytic cracking apparatus including a reaction chamber and a regeneration chamber and an apparatus for flowing a finely divided solid as a suspension in a gaseous medium through a vertical conduit are claimed. The apparatus is constructed so as to maintain a suspension of catalyst or similar particles in the gaseous medium. A baffle structure is provided in the vertical conduit to distribute the solid particles dropping into the flow of gaseous medium.

ALKYLATION

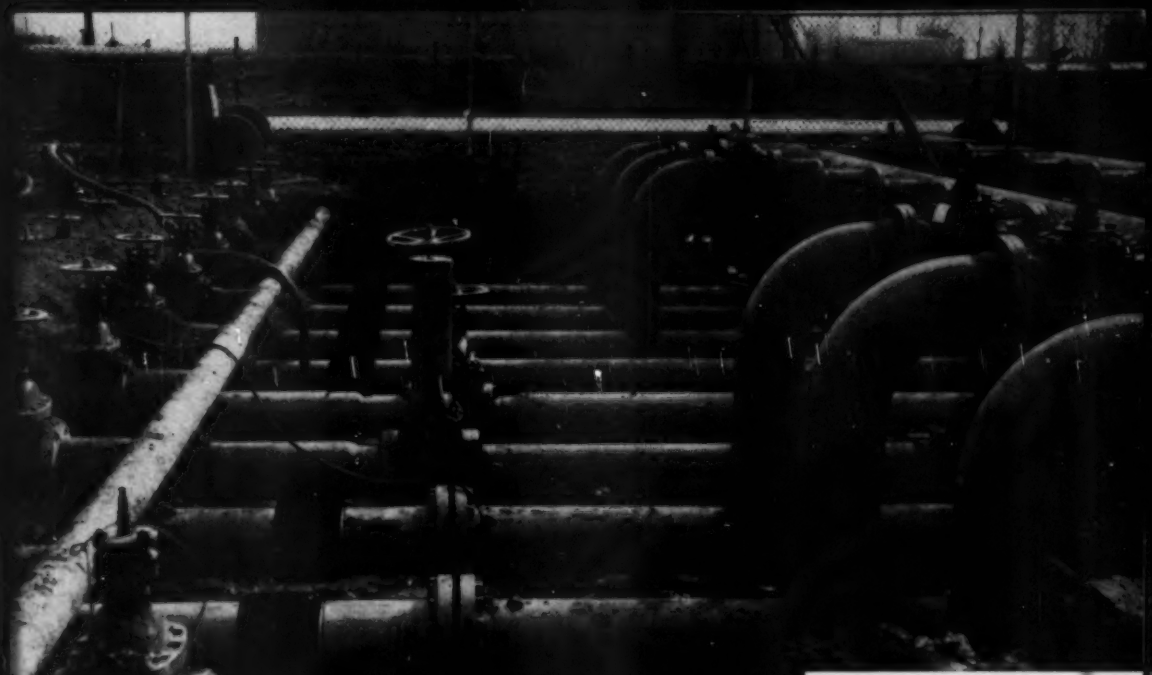
U.S.P. 2,584,103. Alkylation of Aromatic Hydrocarbons. H. Pines and V. N. Ipatieff to Universal Oil Products Company.

An aromatic hydrocarbon having a replaceable nuclear hydrogen atom is alkylated with an olefin-acting compound in the presence of a pre-formed reaction product of alumina with a hydrogen halide, which product shall contain 0.5-30 percent by weight of halogen chemically combined with the alumina.

U.S.P. 2,585,899. Catalysis of Alkyl Aromatic Isomerization. G. E. Lenglois to California Research Corporation.

A dialkyl benzene with not more than three C atoms in each alkyl group, e.g. a xylene feed, is isomerized by contact with a solid isomerization catalyst containing phosphoric acid at a concentration of 95-110 percent calculated as H_3PO_4 at a temperature of 400-1100° F. and a space velocity of 0.05-5.0 volume of liquid dialkylbenzene per volume of catalyst per hour.

U.S.P. 2,585,983. Alkylation Process.



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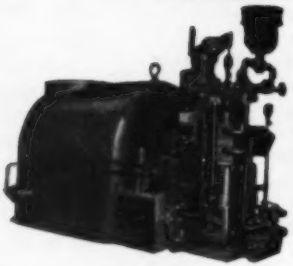

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Patents

C. E. Adams, W. A. Proell, and E. G. Ballweber to Standard Oil Company. (Indiana).

A monocyclic aromatic hydrocarbon is alkylated with an olefinic hydrocarbon fraction comprising a substantial amount of preferentially oil-soluble neutral oxygenated organic compounds in the presence of a liquid sulfonic acid catalyst in a quantity sufficient to form a distinct liquid phase, at a temperature of 230°-300° F. Water is withdrawn as a vapor from the alkylation zone at a rate sufficient to preclude the accumulation of water in this zone. At least some of the oxygenated compounds present undergo dehydration under the alkylation conditions.

U.S.P. 2,586,729. Production of Ammonium Sulfate. A. J. Shmidl to Standard Oil Development Company.

Sulfuric acid sludge derived from the alkylation of olefins with isoparaffins in the presence of strong H_2SO_4 is heated to a temperature of 280-325° F. The resulting gelled heated sludge is mixed with NH_4OH for neutralization. Carbonaceous bodies from the sludge material are removed, and an aqueous solution of ammonium sulfate is recovered.

ISOMERIZATION

U.S.P. 2,583,739. Catalytic Isomerization of Isoheptanes to Triptane. J. D. Kemp and A. E. Strickland to California Research Corporation.

A liquid feed consisting predominantly of methyl hexanes and dimethyl pentanes is contacted with a HF-BF_3 isomerization catalyst containing 5-25 percent by weight of BF_3, at a temperature of 25-75° F., in the presence of 2-20 volumes of liquid propane per volume of feed. The formation of undesired side reaction products, especially 2, 2-and 3, 3-dimethyl pentane is substantially reduced in this selective isomerization of isoheptanes to form triptane.

U.S.P. 2,583,740. Two-Stage Isomerization of N-Heptane. J. D. Kemp to California Research Corporation.

The process of this patent is related to that of U.S.P. 2,583,739. The catalyst here consists of HF and 8-12 percent of BF_3. A mixture of one volume, n-heptane and 2-4 volumes of isobutane is contacted with this catalyst at a temperature of 90-125° F. for not more than 30 minutes. The isoheptane concentrate separated from the reaction product is further treated with a HF-BF_3 catalyst containing 13-19 percent BF_3 at a temperature of 25-60° F. in the presence of 6-12 volumes of liquid propane.

POLYMERIZATION AND CONVERSION

U.S.P. 2,584,378. Flow Control of Particles in Fluidized Processing. J. Beam to Universal Oil Products Company.

In passing a hydrocarbon stream upwardly through a fluidized bed of subdivided solid particles, such particles are continuously withdrawn downwardly from the fluidized bed in a relatively dense phase fluidized column and are discharged into a transfer conduit dis-

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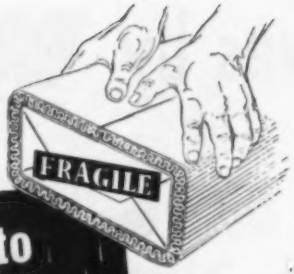

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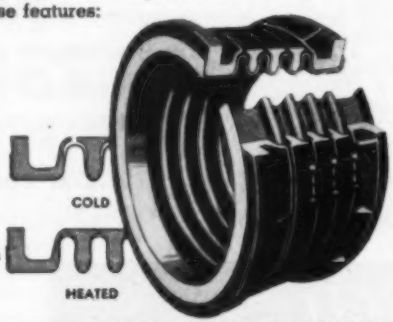

BADGER MANUFACTURING COMPANY
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Patents

posed transversely to this column and communicating with another zone where the particles are to be transferred. At least two jet streams are maintained in the conduit below the column, one of these jets being directed upwardly into the column in a manner hindering the discharge of particles therefrom, while another jet is directed away from the column in the direction of the other zone.

U.S.P. 2,584,621. Pebble Heater. M. A. Ryan to Phillips Petroleum Company.

The construction is claimed of a vessel for effecting heat exchange between upflowing gases and down-flowing pebbles.

U.S.P. 2,585,238. Method and Apparatus for Effecting the Fluidized Catalytic Conversion of a Reactant Stream. C. G. Gerhold to Universal Oil Products Company.

Details are claimed of a process for contacting sub-divided solid particles in a fluidized hydrocarbon conversion operation.

U.S.P. 2,585,867. Process for Polymerizing Isoolefins Using Methyl Chloride Solution of BF_3 as Catalyst. W. J. Sparks and R. M. Thomas to Jasco, Inc.

A mixture of a mono-olefin and a multiolefin, wherein the mono-olefin has 4-20 C atoms and is present in the proportion of 10-90 percent, and the multiolefin has 4-14 C atoms and is present in the proportion of 90-10 percent e.g. of isobutylene and isoprene, is cooled to a temperature of —40° to —103° C. and copolymerized by the addition of BF_3 in methyl chloride solution.

U.S.P. 2,585,984. Pebble Heater Apparatus and Method for Heat Exchange. C. Alexander and H. A. Dutcher to Phillips Petroleum Company.

Hot pebbles heated in a special manner are freely falling through a conversion zone for hydrocarbon gas to be converted.

U.S.P. 2,586,092. Emulsion Copolymerization of Styrene with Bodied Oil or Bodied Oil Modified Alkyd. R. S. Robinson to Reichhold Chemicals, Inc.

Styrene and bodied linseed or bodied dehydrated castor oil are suspended in an aqueous medium and copolymerized at a temperature of 55-65° C.

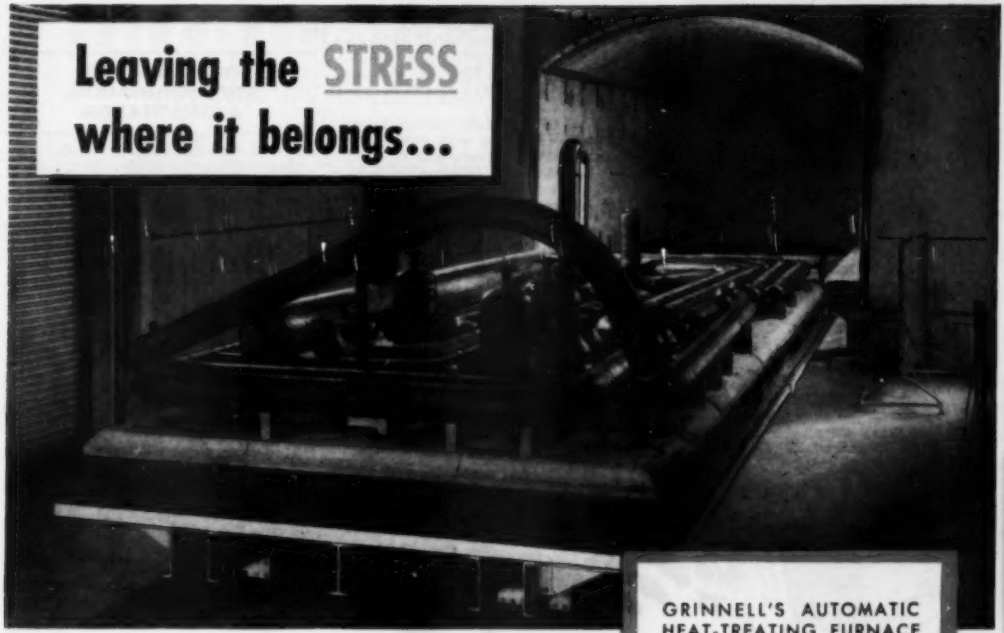
U.S.P. 2,586,322. Process for Controlling Chain Branching During Ethylene Polymerization. W. A. Franta to E. I. du Pont de Nemours & Company.

Ethylene-homopolymers of certain characteristics are prepared by polymerizing ethylene in the presence of water, catalyst, and cyclohexane at a temperature of 140-200° C., under a pressure of 1200-2000 atmospheres.

U.S.P. 2,586,571. Styrene Copolymers. J. J. Sleightholme to The Sherwin-Williams Company.

Styrene is heated with the unsaturated aromatic extract obtained from lubricating oils treated by the Edeleanu process to form a copolymer.

Leaving the STRESS where it belongs...



Stress relieving prefabricated piping with highly developed equipment and special techniques is one reason why exacting specifications are met with

GRINNELL PREFABRICATED PIPING

Grinnell received an order recently for stress relieving prefabricated piping to these specifications:—

> "All fabricated pieces shall be normalized and drawn by heating to a uniform temperature of 1700°F (plus or minus 25°F). This temperature shall be maintained on a basis of one-half hour for each quarter inch of wall thickness of the heaviest pipe in the furnace charge followed by air cooling not less than 600°F. All pieces shall then be reheated to 1425°F and held at temperatures as above. In no case shall the time be less than 2 hours . . . Cool at a controlled rate not to exceed 200°F per hour until 600°F is reached . . ."

Grinnell, of course, met these specifications precisely. In fact, fabricating industrial piping today demands the *maximum* in versatility and precision.

Modern power plants, for example, need piping of heavy cross-sectional area and definite alloy composition to provide high temperature stability, resistance to creep and graphitization. Chemical and oil refining processes, on the other hand, must have piping of high chrome alloy to impart strength at high temperatures, resist corrosion, withstand impacts at low temperatures. Heat-treating often is the only answer — either to restore properties affected during fabrication, or improve original properties.

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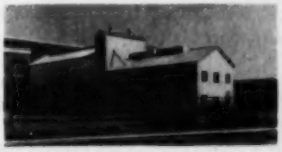
performs with positive efficiency. This versatile stress-relieving unit, measuring 12 by 12 by 40 feet and using gas or oil or both as fuel, was designed to give full program control for the entire range of working temperatures. It provides instrument control of rate of rise in temperature of the charge, length of time for holding at the predetermined temperature level, and cooling rate. Two recording controllers are provided for the furnace and a separate 6-point recorder registers the temperatures of the charge simultaneously during the treating cycle.



Exterior View of Building

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Patents

U.S.P. 2,586,572. Styrene Drying-Oil Copolymers. J. J. Sleightholme and W. T. C. Tammond to The Sherwin-Williams Company.

The process of this patent is closely related to that of U.S.P. 2,586,571. A polyhydric alcoholic mixed ester containing unsaturated drying oil fatty acid radicals is here added to the mixture to be polymerized.

U.S.P. 2,586,593. Manufacture of Interpolymers of Styrene with Unsaturated Fatty Acids and Polyhydric Alcoholic Esters Thereof. F. Armitage and J. J. Sleightholme to The Sherwin-Williams Company.

Styrene or nuclear alkyl substituted styrene derivatives are heated with a drying oil acid or a polyhydric alcoholic ester thereof in the presence of an alpha-terpene activated by blowing with an oxygen containing gas.

U.S.P. 2,586,652. Manufacture of Interpolymers of Styrene with Polyhydric Alcoholic Mixed Esters and of Coating Compositions Obtained Therefrom. D. H. Hewitt and F. Armitage to The Sherwin-Williams Company.

The process of this patent is related to that of U.S.P. 2,586,593. Partially polymerized esters of fatty acids or phthalic acid and at least one polyhydric alcohol, or fatty acid modified resins are here heated with styrene in certain proportions. A soluble homogeneous interpolymer of air drying properties is produced.

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HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,583,611. Method for the Synthesis of Hydrocarbons in the Presence of a Solid Adsorbent. F. W. Sullivan, Jr., to Hydrocarbon Research, Inc.

Synthesis gas in continuously passed through a dense fluidized mass of relatively coarse catalyst particles under synthesis conditions with fine adsorbent particles suspended in the gas, which adsorbent particles are capable of adsorbing a substantial amount of the normally liquid reaction products at the reaction temperature. The rich adsorbent is withdrawn from the upper portion of the reaction zone, and the adsorbed products are then recovered therefrom.

U.S.P. 2,583,620. Separation of Organic Compounds. J. M. Wrightson to The M. W. Kellogg Company.

Details are claimed of a process for separating the hydrocarbon and oxygenated organic Fischer-Tropsch synthesis products boiling between 150-400° F. from another, wherein the hydrocarbon rich phase is subjected to a first extraction with a glycol solvent for the oxygenated products.

U.S.P. 2,584,269. Separation of Oxygenated Organic Compounds from Synthetic Naphtha. L. P. Hodges to Standard Oil Development Company.

A synthetic raw naphtha containing about 20 percent by weight of oxygenated organic compounds is mixed with a hydrocarbon fraction boiling in the lubricating oil range, an alkali metal naphthenate, and an alkali metal hydroxide. The mixture is subjected to distillation. A fraction boiling in the gasoline range and free of the oxygenated compounds is recovered from the distillation.

U.S.P. 2,584,391. Apparatus for Effecting Fluidized Contact between Solid Particles and Fluid Mediums. F. W. Leffer to Universal Oil Products Company.

The construction is claimed of an apparatus for non-mechanically contacting fluid media with subdivided solid particles, e.g. in exothermic reactions, such as a Fischer-Tropsch synthesis, or the catalytic hydrogenation of olefinic compounds with regeneration of the catalysts.

U.S.P. 2,584,531. Metal Molybdite Catalyzed Hydrogenation Process. H. R. Arnold and J. E. Carnahan to E. I. du Pont de Nemours and Company.

In the hydrogenation of unsaturated hydrocarbons, e.g. in the conversion of cyclohexene to cyclohexane, the unsaturated hydrocarbon is contacted at a temperature of 70-450° C. with hydrogen and a molybdite of a metal, such as nickel, whose ions are soluble in aqueous ammonia in amount greater than that stoichiometrically required to precipitate the metal ion. The acid of the molybdite may be of the formulas H_3MoO_4 or H_2MoO_3.

U.S.P. 2,585,274. Catalytic Reactor. E.

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In Wisconsin: General Chemical Company, Inc., Milwaukee, Wis.
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

Patents

H. Reichl to Stanolind Oil and Gas Company.

The construction is claimed of an apparatus for the catalytic synthesis of hydrocarbons from CO and H_2. It permits to remove the exothermic heat of the reaction and control of the reaction temperature within a relatively narrow range.

U.S.P. 2,585,337. Destructive Hydrogenation of Hydrocarbon Oils with Molybdenum Oxide Catalyst. J. B. McKinley to Gulf Research and Development Company.

Hydrocarbon oil vapors are contacted with hydrogen at elevated temperature and pressure in the presence of a silica-alumina cracking catalyst composited with 0.5-4 percent of molybdenum trioxide and obtained by impregnating the base with aqueous $MoCl_5$, drying and calcining to form molybdenum trioxide.

U.S.P. 2,585,441. Catalytic Reactor. P. W. Cornell and E. Cotton to Gulf Oil Corporation.

The construction is claimed of an apparatus for conducting catalytic chemical reactions such as a Fischer-Tropsch synthesis. The apparatus makes it possible to carry out exothermic and endothermic reactions in such a manner as to minimize the work required to circulate large quantities of fluids for controlling the temperature of the reaction.

U.S.P. 2,585,462. Catalytic Apparatus. J. H. Hirsch to Gulf Research and Development Company.

An apparatus is claimed for conducting catalytic reactions, such as the synthesis of liquid hydrocarbons from a CO/H_2 mixture. The apparatus fills a similar purpose as that of U.S.P. 2,585,441.

U.S.P. 2,585,981. Process for Catalytic Conversion of Carbon Oxides. C. W. Watson to The Texas Company.

A gaseous mixture of CO, H_2, CO_2 and water vapor is reacted with fluidized iron catalyst particles at a temperature of 550-700° F. until 0.95-0.995 of the CO has been converted into desired hydrocarbons and oxygenated hydrocarbons. The composition of the gaseous feed is maintained such that the mole ratio of H_2:CO is at least 2:1, the amount of water vapor is not more than that corresponding to saturation at 100° F., and the proportion of CO_2 is sufficient to repress action of the water gas shift reaction in that direction which consumes CO and H_2O with the formation of CO_2. Conversion of CO into CO_2 is thus inhibited.

U.S.P. 2,586,377. Dehydrogenation of Hydrocarbons with Synthetic Gel-Type Metal Oxide Catalysts. E. W. Pitzer to Phillips Petroleum Company.

Hydrocarbons with 2-10 C atoms, such as n-butane, cyclohexane, or ethyl benzene are dehydrogenated in the presence of a synthetic gel catalyst of alumina, beryllia and an oxide of V, Cr, Mo, or W at a temperature of 900-1300° F. and a pressure up to 500 psig. The catalyst is prepared in a special manner.

U.S.P. 2,586,535. Catalytic Hydrogenation of Aromatic Hydrocarbons in a Stainless Steel Reactor. V. N. Ipatieff and H. Pines to Universal Oil Products Company.

Aromatic hydrocarbons are hydrogenated in the presence of nickel-containing stainless steel and of a catalyst composite comprising copper and alumina. Temperatures of 200-400° C. and pressures of 50-200 atmospheres are preferably used.

U.S.P. 2,586,618. Hydrocarbon Synthesis Process. J. C. Dart to Standard Oil Development Company.

In a Fischer-Tropsch synthesis process, a vaporous stream is withdrawn from the reaction zone at a point intermediate the point of introduction of the CO/H_2 feed and the point of withdrawal of synthesized hydrocarbons. The vaporous stream is first cooled to remove water, then treated to remove CO_2 therefrom, and then returned to the reaction zone. By this procedure the synthesis catalyst is maintained in a reduced state.

DESULFURIZATION

U.S.P. 2,584,248. Recovery of Sulfur Compounds from Petroleum. R. E. Barieau to California Research Corporation.

Sulfur containing petroleum oils are first extracted with a mineral acid of a

From the recovery of liquids entrained in discharge gases to the removal of contaminators to further processing, these simple knitted-wire pads are daily contributing to greater on-grade throughput, increased efficiency and lowered costs in refineries from coast to coast.

Metex Mist Eliminators do just one thing — remove liquids entrained in gases. The diagram shows how they are doing it in stills, towers, cats, knock-outs, evaporators and other vessels.

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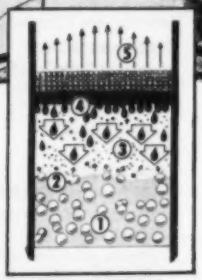

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concentration not higher than 80 percent by weight. The raffinate of this extraction is then extracted with HF of at least 85 percent concentration. The thus resulting extract predominantly consists of organic sulfur compounds.

U.S.P. 2,585,284. Mercaptan Extraction. T. B. Tom and J. A. Bolt to Standard Oil Company (Indiana).

High boiling mercaptans are removed from a petroleum distillate boiling between 350-600° F. by intimately contacting this distillate with a mixture of certain proportions of dissolved aqueous alkali metal hydroxides, methanol and an alkali metal salt of an alkoxyalkyl carboxylic acid having 4-8 C atoms.

HEAVY OILS AND WAXES

U.S.P. 2,583,603. Substituted Thickener Lubricating Grease. A. F. Sirianni and I. E. Puddington to The Honorable Advisory Council for Scientific and Industrial Research, Ottawa.

A mineral base lubricating oil is thickened to grease consistency by 1-20 percent of an inorganic oxygen containing gel voluminous precipitate having its normal liquid content replaced by the lubricating oil, and 0.5-2 percent of a polystyrene water-proofing agent covering the precipitate in a compressed monolayer coating to inhibit moisture absorption by the precipitate. The gel may preferably be formed by silica gel, $Al(OH)_3$ or $Fe(OH)_3$.

U.S.P. 2,583,605-6. Silica Base Lubricating Grease. A. F. Sirianni and I. E. Puddington to The Honorable Advisory Council for Scientific and Industrial Research.

The grease materials according to these patents are closely related to that of U.S.P. 2,583,603. The water-proofing agent is here formed by 10-100 percent (of the dry weight of the silica gel employed) of a linseed oil modified alkyd or glyptal resin or of an organo silicon polymer.

U.S.P. 2,583,607. Complex Soap Greases. A. F. Sirianni and I. E. Puddington to The Honorable Advisory Council for Scientific and Industrial Research.

A mineral base lubricating oil is thickened to grease consistency with 5-20 percent of a complex polyvalent metal salt of one mole part of C_{28} to C_{36} fatty acid and 3-15 mole parts of C_2 to C_4 dibasic carboxylic acid. The normal water content of the salt is replaced by the oil to form a stable gel structure.

U.S.P. 2,584,085. Lubricant. F. H. Stross to Shell Development Company.

A lubricant comprises 5-20 parts by weight of a mineral lubricating oil, one part of an inorganic aerogel, e.g. silica aerogel, and 0.5-5 parts of polymerized alkylhalosilane, such as dimethyldichlorosilane. The silane is sorbed on the gel while the latter is dispersed in the oil. The product forms a thixotropic gel or grease.

U.S.P. 2,584,930. Oil Base Drilling Fluid. H. Shinouda to Shell Development Company.

A drilling fluid comprises an aromatic mineral oil, a finely divided dispersed weighting material, and 1-20 percent by weight of the oil of a micro-crystalline paraffin wax suspended in the oil.

U.S.P. 2,584,966. Chilling of Oils. E. J. Reeves to Socony-Vacuum Oil Company, Inc.

A method of dewaxing a wax-bearing oil is claimed in detail. The adherence of ice on the inner surfaces of the chilling equipment employed is inhibited by cooling the solvent containing aqueous contaminant to just above the temperature at which the formation of ice takes place and thereafter shock-chilling the wet solvent with a cold stream of oil.

U.S.P. 2,584,977. Lubricating Oil Additives. J. D. Bartleson to the Standard Oil Company (Ohio).

A mineral lubricating oil contains a minor amount of an oil-dispersible cation radical derivative of an aliphatic nitrile

Patents

having 12-18 C atoms and a phosphorus sulfide reacted at a temperature of 400° F. The additive stabilizes the oil against oxidation.

U.S.P. 2,585,321. High-Temperature Grease. R. A. Butcosk to Socony-Vacuum Oil Company, Inc.

A mineral oil is compounded with 5-25 percent by weight of a lithium soap and 10-50 percent of an ester of an oxy-acid of phosphorus. The resulting grease retains its original gel structure at temperatures of 400-500° F.

U.S.P. 2,585,520. Lubricating Composi-

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Patents

tions Containing Highly Basic Metal Sulfonates. P. R. v. Ess and H. E. Sipple to Shell Development Company.

A mineral lubricating oil contains a minor proportion of a highly basic divalent metal petroleum sulfonate of a strongly basic group II metal of certain characteristics and prepared in a particular manner.

U.S.P. 2,585,813. Hydrocarbon Oil Composition. J. P. McDermott to Standard Oil Development Company.

A mineral oil contains a minor amount of a mixed acid anhydride of the formula $(RO_3)\ P-S-SO_2R^1$, wherein R is a

$$\begin{matrix} \| \\ S \end{matrix}$$

hydrocarbon radical and R^1 is an aliphatic or aromatic hydrocarbon radical and R and R^1 each contain 1-30 C atoms. The additive has oxidation inhibiting qualities.

U.S.P. 2,585,820. Lubricating Composition. L. G. Morell and A. T. Knutson to The Dow Chemical Company.

A mineral lubricating oil contains a small amount of a non-volatile chlorinated paraffin hydrocarbon. The composition is useful as a cutting oil.

U.S.P. 2,585,874. Treating Lubricating Distillates. C. W. Stratford to Stratford Engineering Corporation.

Lubricating oil distillate is heated, dehydrated and deaerated and then subjected to acid treatment in a plurality of steps with intermediate steps of acid oil separation. Volatile sulfur compounds are removed in the vapor phase in a stage of reduced pressure after the acid treatment. The treated oil is then subjected to treatment with water, neutralization and drying.

U.S.P. 2,585,877. Lubricating Oil Composition. H. S. Trigg, H. D. Norris, and R. V. White to Socony-Vacuum Oil Company, Inc.

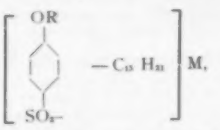
A mineral oil contains a minor amount of an ester of a trialkylammonium acid salt of a hydroxy aliphatic dicarboxylic acid and a primary aliphatic monohydric alcohol containing 12-31 C atoms. The alkyl radicals in the trialkylammonium group of the salt can contain up to 6 C atoms. The ester of tri-n-butylammonium acid maleate and oleyl alcohol is an example of the additives employed, which improve the antiwear properties and the cutting efficiencies of the oil.

U.S.P. 2,585,895 Wax Refining. P. F. Dougherty and C. H. Brooks to Sun Oil Company.

Details are claimed of a process for deodorizing and decolorizing a petroleum wax of a m.p. of 100-200° F. by treatment with clay at elevated temperature.

U.S.P. 2,586,191. Salts of Sulfonated Ethers of Hydrogenated Cardanol as Inhibitors for Mineral Hydrocarbon Oils. D. Wasserman to The Harvel Corporation.

A mineral hydrocarbon oil having a flash point no lower than 250° F. and useful for lubricating, aviation, turbine and diesel purposes contains a small amount of a compound of the formula



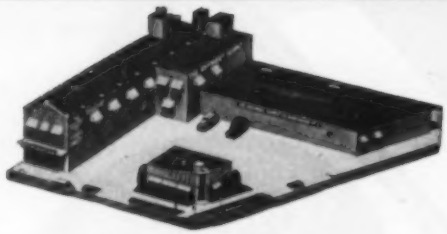
where R is an alkyl group and M is a metal, such as Zn, Ca, or Ba. The additive improves the corrosion and oxidation characteristics of the oil.

U.S.P. 2,586,198. Refining of Wax. P. S. Backlund and P. L. Polizzotto to Union Oil Company of Indiana.

Wax containing asphaltic and resinous color bodies is contacted with magnesia at a temperature above the m.p. of the wax. The resulting mixture is extracted with a saturated alcohol, ketone, or ether containing less than 6 C atoms. The solution of decolorized wax obtained is separated from a mixture of magnesia and the color bodies.

U.S.P. 2,586,590. Manufacture of Lubricating Oils from Shale Oil. P. Woog to Companie Française de Raffinage (Soc. Anon.).

Crude shale oil is fractionated to remove paraffin fractions. Aromatic hydrocarbons are added to the residue, and the resulting mixture is heated in the presence of a Friedel-Crafts catalyst to simultaneously polymerize and arylate unsaturated constituents of the oil. A high grade lubricant is obtained.



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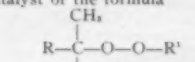
U.S.P. 2,586,594. Preparation of Drying Oils from Diolefins. E. Arundale, A. H. Gleason, and F. W. Banes to Standard Oil Development Company.

A conjugated diolefin of 4-6 C atoms is heated at a temperature of 50-150° C. under a pressure of 3-30 atmospheres in the presence of 1-3 mole percent per mole of monomer of a hydrocarbon soluble catalyst of the formula



wherein R is methyl or phenyl and R' is hydrogen or benzoyl. The heating is effected for a period to convert not more than 80 percent of the diolefin into a linear oily polymer with a mole weight of 1000-20,000.

U.S.P. 2,586,693. Lubricating Grease. A. J. Morway and L. A. Mikeska to Standard Oil Development Company.

A lubricating oil is thickened to grease consistency with certain proportions of alkali metal soaps of a high mole weight saturated fatty acid having 16-20 C atoms, such as hydrogenated fish oil, a low mole weight fatty acid having 1-4 C atoms, and an aryl-aliphatic acid containing a hydrocarbon chain of 8-20 C atoms in the aliphatic portion, such as xylyl-stearic acid.

PETROCHEMICALS

U.S.P. 2,583,984. Production of Nitriles. P. Arthur, Jr., to E. I. du Pont de Nemours and Company.

A mixture of 1,3-butadiene, cuprous cyanide, and Fe Cl_3 or Fe Br_3 is heated to a temperature above 75° C. in the presence of a sufficient quantity of water to form at least some hexahydrate with the ferric halide, and in the presence of an aromatic hydrocarbon that is liquid at reaction temperature. Nitriles are formed.

U.S.P. 2,584,112. Organic Phosphines. H. C. Brown to Standard Oil Company (Indiana).

Organic phosphines are produced by contacting an olefin with phosphine and a strong non-oxidizing acid catalyst, such as HF or a hydrocarbon sulfonic acid, under suitable conditions, e.g. at a temperature of 0-250° C.

U.S.P. 2,585,129. Process of Preparing Fatty Compounds. A. I. Gebhart and J. Ross to Colgate-Palmolive-Peet Company.

A monoolefin of the formula $R_1 = R_2$ wherein R_1 and R_2 are alkyl groups of which one group at least contains an odd number of C atoms not less than seven is reacted with peracetic acid in a solution of acetic acid to selectively oxidize the mono-olefin and form a hydroxy-substituted saturated hydrocarbon which is further treated to prepare a corresponding fatty acid compound in a unitary process.

U.S.P. 2,585,469. Process for the Manufacture of Chloromethanes. P. R. Johnson to E. I. du Pont de Nemours and Company.

A mixture of methane with 20-60 percent hydrogen is passed together with chlorine through a bed of finely divided inert solids in such a manner that the inert solids are maintained in a fluidized turbulent condition. The temperature of the bed is maintained at 325-450° C. The chlorine is added in increments such that the chlorine concentration at any point in the bed does not exceed the ignition threshold concentration for the bed temperature. Chloroform, carbon tetrachloride and H Cl are predominantly produced.

U.S.P. 2,585,478-9. Production of Olefin Oxides. N. Levy to Imperial Chemical Industries, Ltd.

A mixture of ethylene and an oxygen-containing gas is reacted in the vapor phase at a temperature of 150-400° C. in the presence of a silver-containing catalyst comprising separately prepared Ag_2O in mixture with 0.5-50 percent of powdered fused silica or quartz.

U.S.P. 2,585,483. Production of Ethylene Oxide. F. C. Mawer to Imperial Chemical Industries, Ltd.

The process according to this patent is closely related to that of the U.S.P.'s 2,585,478-9. Sodium aluminum silicate with a certain proportion of silica, sodium oxide and alumina is here employed as the carrier for the silver oxide catalyst.

U.S.P. 2,585,723. Production of Aliphatic Acids. F. W. Banes, W. P. Fitz Gerald and J. F. Nelson to Standard Oil Development Company.

Higher saturated aliphatic acids are obtained by reacting a carboxylic acid containing 1-5 C atoms with ethylene in the presence of di-tertiary butyl perox-

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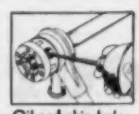

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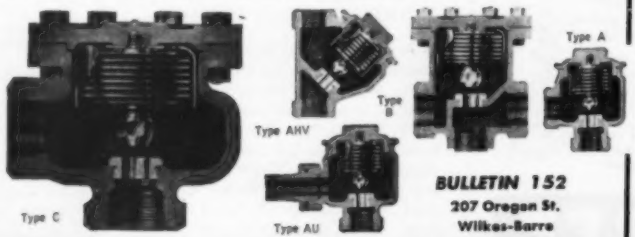

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Patents

ide at a temperature of 145°-170° C. and a pressure of 800-1000 psi. for 1-4 hours.

U.S.P. 2,586,128. Preparation of Phthalic Anhydride from 3,4,0, Bicyclic Nonyl Hydrocarbon. F. T. Wadsworth to Pan American Refining Corporation.

Vaporized non-aromatic 3,4,0, bicyclic nonyl hydrocarbon admixed with large amounts of air is contacted with a solid oxidation catalyst, such as supported vanadium oxide, at a temperature of 290-420° C., whereby aromatization and dehydrogenation is effected and phthalic anhydride is produced.

U.S.P. 2,586,341. Process for Producing Trans-3-Pentenoic Acid. A. M. Hyson to E. I. du Pont de Nemours and Company.

Butadiene is heated with CO and water in the presence of dimethylformamide or -acetamide and a cobalt carbonyl catalyst at a temperature of 100-250° C. under a pressure of at least 700 atmospheres. Trans-3-pentenoic acid is formed.

U.S.P. 2,586,602. Purification of Alcoholic Liquid. S. B. Beddow to Standard Oil Development Company.

Propylene is absorbed in H_2SO_4. The resulting isopropyl extract is hydrolyzed with water and then steam distilled. The crude isopropanol distilate thus obtained which contains 65-70 percent by volume of isopropyl alcohol is further treated for purification.

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U. S. Government Research maintains a wind tunnel at the University of California for testing parts of airplanes and rockets. In this tunnel, altitudes up to 75 miles in the stratosphere are duplicated by a five stage Evactor, a steam jet vacuum-producing unit designed and built by Croll-Reynolds to work in the range of a few microns of mercury absolute.

Croll-Reynolds five stage Evactors are built in various sizes, the smallest of which handles many times the volume of the largest mechanical vacuum pump. The same careful work and precision which produced these five stage units goes into every C-R Evactor from the one stager yielding a pressure of four or five inches of mercury absolute to the four stage unit designed for work in the range of 0.15 to 3.0 mm. of mercury absolute.

Many thousands of Croll-Reynolds Evactors are in regular operation, some of them for over 30 years. They are installed in every state of the U. S. and in many foreign countries. Let our technical staff help you with your vacuum problems, including flash cooling of water and aqueous solutions.

C-R REYNOLDS

CROLL-REYNOLDS CO., INC.

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17 JOHN STREET, NEW YORK 38, N. Y.
Chill-Vactors Steam Jet Evactors Condensing Equipment

About EQUIPMENT and SERVICE Suppliers

Phil Sprague, Jr. Appointed Executive VP for Hays Company

Phil Sprague, Jr. has been appointed executive vice president of The Hays

Le Boeuf

Sprague

Corporation, Michigan City, Ind., manufacturer of combustion instruments and controls. Sprague, a Beloit College and Harvard Business School graduate has been advertising manager.

Paul G. LeBoeuf, who succeeds Sprague as advertising manager, comes to Hays from A. O. Smith Corporation, Water Heather division, Kankakee, Ill., where he was in charge of advertising and sales promotion.

Dresser Industries Elects Tom Slick Director of Board

Dresser Industries, Inc., Dallas, has elected Tom Slick, a partner in the Slick-Moorman Oil Company and Slick-Urschel Oil Company, and organizer of the Foundation of Applied Research for improvements in agriculture and industry, to the board of directors. During the war, Slick served as a member of the War Production Board, moved to Chile as a member of the Board of Economic Warfare, and in 1942 was commissioned by the Navy.

Slick

During the post war period Slick enlarged his science-research work by establishing the Institute of Inventive Research which develops and licenses inventions of social or economic merit. In 1947 he founded the Southwest Research Institute which conducts agricultural and industrial research for companies, individuals, and government agencies at cost. In addition Slick is director of Slick Airways, Inc., and other companies.

New Sales Assignments Made By Manning, Maxwell & Moore

Manning, Maxwell & Moore, Inc., manufacturer of gauges, valves, industrial instruments and material handling equipment has appointed Morris S. Palmer and Raymond F. Attner to new sales positions in the company. Palmer becomes manager of field sales and Attner, succeeding Palmer, is Hancock valves product manager. Previously a salesman in several territories and district manager in Chicago, Palmer joined the company in 1922. Attner, also with 30 years of service with the company, was previously distributor manager of valves.

Greensward Named Apparatus Manager By Allis-Chalmers

J. D. Greensward has been appointed manager of a newly organized apparatus department at Allis-Chalmers Manufacturing Company and will continue as general manager of the concern's Norwood works, a position he has occupied since 1949. Prior to that he served in an executive capacity in the company's West Allis works. He has been with Allis-Chalmers since 1922.

E. F. Drew Changes Territorial Posts For District Engineers

E. F. Drew & Company has announced several changes in territorial assignments for district engineers, as well as recent additions to the Drew Power Chemical organization. Transfers included B. S. Farley, formerly of St.

WIRE MESH

Maybe it all *does* look pretty much the same at first glance. But when a firm has been making wire mesh for 70 years man and boy, there's bound to be little more to it than meets the eye — a little more know-how in engineering and weaving, a little more quality in the product, a little more service and satisfaction for the user.

JELLIFF WIRE MESH is woven in all ductile metals

JELLIFF WIRE MESH is woven in all commercial weaves

JELLIFF WIRE MESH is woven in widths up to 72 inches

JELLIFF WIRE MESH is economical. Every foot runs true to the specifications.

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JELLIFF WIRE MESH is a quality product and has been for 70 years. You can depend on it.

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DIPPING BASKETS · LEKTROMESH · RESISTANCE WIRE
WIRE MESH PARTS · WIRE CLOTH · STRAINERS · FILTERS
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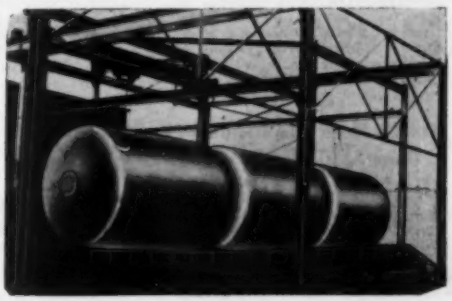

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3—96" O.D. ASME Tanks

Back of every vessel shipped is CONTINENTAL'S reputation for quality construction.

And when your plans call for fabricated steel plates, you'll find that CONTINENTAL quality and economy go hand-in-hand. For prompt estimates write today—Dept. E.

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Fast, Low Cost

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- Wet and Dry Sandblasting.

BONDACTOR offers refineries an opportunity to save time and money . . . to do a better, faster job wherever air application or gunning of cementitious materials is needed. And Bondactor pays for itself in savings!

Here's How the Industry Uses BONDACT PROCESS EQUIPMENT

- Gunning of castable refractories in catalytic regenerator linings, steam generators, stack linings, breeching linings, flue linings, stills and furnaces
- Fireproofing of pipe lines, saddles, beams
- Acid-proofing of concrete and ditch linings
- Steel tank lining and exterior insulation
- Insulating of steel buildings and construction of insulated curtain walls
- Repair and maintenance of existing structures
- Many new construction techniques.

Now Available...to fit your needs.
Model #1000-S requires 100 CFM at 90 p.s.i.
Model #1000-L requires 200 CFM at 90 p.s.i.
Both units can be operated from either plant air or portable air compressors.

For Free Catalog, Write

AIR PLACEMENT
EQUIPMENT COMPANY
1013 West 24th St., Kansas City 8, Mo.

Louis, as the new district engineer in Baltimore; James Quigley has been transferred from the Baltimore branch to district engineer in the Newark area. New appointments listed A. L. Stahl, district engineer in Chicago; A. W. Gorline, service manager for the St. Louis office; Arthur Swenson, district engineer in Syracuse; J. D. Gibson, district engineer in Knoxville; Ralph D. Bartow, district engineer in Tulsa; C. R. Oller, district engineer in Oakland country, Calif., and A. J. Powers will cover the San Francisco area as district engineer.

Hood Elected Worthington VP; Other Promotions Announced

Worthington Pump and Machinery Corporation has announced the election of C. K. Hood, formerly manager of the corporation's New York district sales office, to a vice presidency, and revealed several personnel promotions in other divisions. Hood, a graduate of Iowa State College and an employe of the Worthington Corporation since 1918, will direct the public works, steam power, deaerating, water treating and steam turbine divisions. W. J. Van Vleck, present manager of the corporation's Atlanta district sales office, will succeed Hood as manager of the New York office. C. W. Kramer, resident general line salesman in Birmingham, Ala., will succeed Van Vleck as manager of the Atlanta office. I. W. Leggett, general line salesman at Charlotte, N. C., has been appointed manager of the Charlotte branch office.

Hood

A. L. Jones, former sales manager of the water treating and deaerator section of the steam and power division, has been appointed manager of the Water Treating division, and Donald W. Bedell has been named Industrial Relations assistant to L. C. Ricketts, manufacturing vice president.

O-T-M Supply Company Opens Division Sales Office in Tulsa

A division sales office of the O-T-M Supply Company of Houston has been established in Tulsa by W. C. "Bill" Evans. O-T-M manufactures and distributes O-T-M "Blue Ribbon" flanges and other industrial piping. Besides opening the Tulsa sales office, present expansion plans include building a new Houston plant, to be occupied this year. The complete facilities of the new plant, buildings, property and increased equipment are estimated at more than a million dollars, company officials say. Evans made his home in Tulsa for a number of years prior to 1940, when he moved to Houston to serve with Shell Oil and the Southwest Company.

Alloy Steel Names Simmons New Western Sales Representative

Appointment of William P. Simmons as sales representative for the western territory comprising the states of California, Oregon, Washington, Idaho, Utah, Nevada and Arizona, has been announced by Alloy Steel Products Com-

The high-heat resistance of MACBETH Brand Gauge Glasses means safer operation and longer life for high pressure boiler service. Designed now for pressures up to 1500 p.s.i. for steam boiler use and up to 5000 p.s.i. at normal temperatures. Uniform dimensions assure tight, accurate fittings on all standard gauges. Made of hard, chemically resistant glass, they stay clear under the most difficult operating conditions. They are easy to read, even from a distance.

Two types of MACBETH Brand Gauge Glasses available—Type A (Plain) used in pairs with water column between—Type B (Reflex) with full length prisms used singly with prisms on water side.

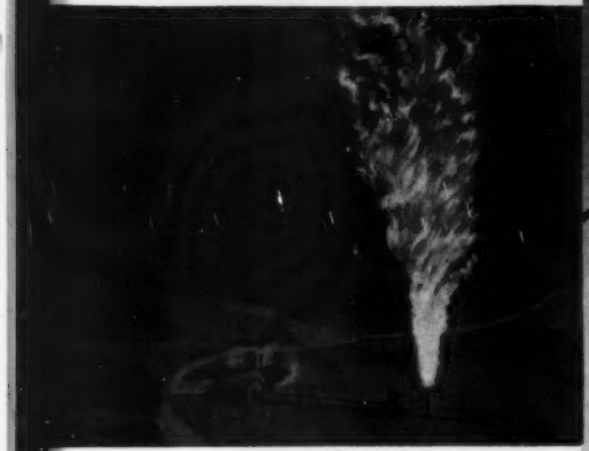
Higher safe operating pressures can be maintained because the low coefficient of expansion of MACBETH Brand Gauge Glasses permits heavier glass construction for additional mechanical strength.

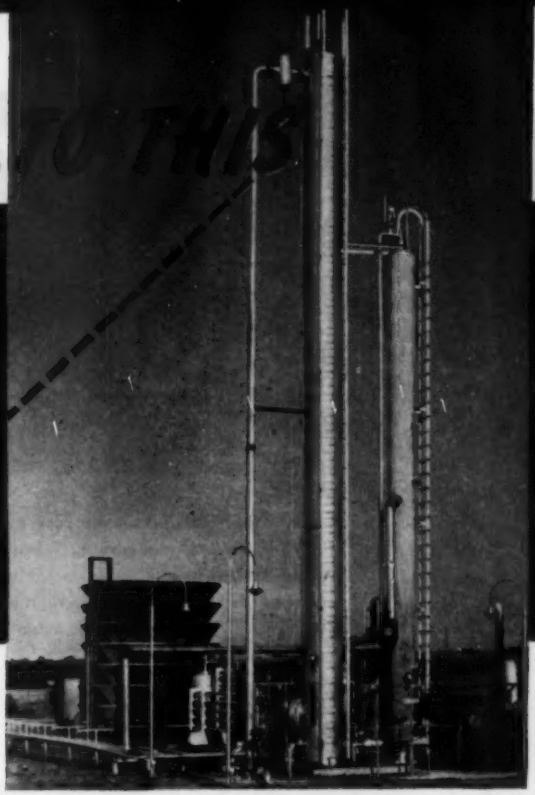
Order MACBETH Brand Flat Gauge Glasses from your Mill Supply Distributor. He also stocks PYREX and CORNING Brand Tubular Gauge Glasses, PYREX Brand Sight Glasses, Oil Cup and Lubricator Glasses.

MACBETH
CORNING
GLASS WORKS
Corning, New York

VISIT THE CORNING GLASS CENTER

FROM THIS... TO THIS





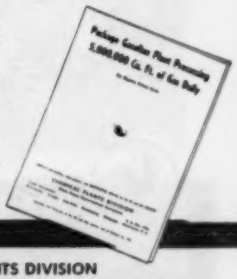
with a BLAW-KNOX PACKAGED GASOLINE PLANT

In self interest and sometimes in self defense it is advantageous to recover small amounts of casing-head or stock-tank vapors. For this specific purpose Chemical Plants Division of Blaw-Knox Construction Company offers a packaged plant featuring:

1. **The compactness and economy of "packaged" design and construction.**
2. **Skid mounting of the major plant units gives the plant better than 80% salvage value.**
3. **The elimination of steam for operating.**
4. **Relatively low labor requirements.**
5. **Gas operated instrumentation (no air required).**

Chemical Plants Division offers you the combined technical know-how of 300 engineers experienced in gasoline plant and refinery design. In this group are also a large number of experienced operational engineers, fully familiar with the problems involved in this type of plant. Our Southwest Division, located in Tulsa is specially fitted to serve the natural gasoline and petroleum industry. We invite your telephone call at Tulsa 5-8221, for more detailed information and will be glad to prepare proposals for your particular needs.

Advantages of this profitable plant are described in "Package Gasoline Plant Processing 5,000,000 cu. ft. of Gas Daily" by T. P. Cook, Chief Process Engineer of the Southwest Division of Blaw-Knox. Write for a copy.



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BLAW-KNOX CONSTRUCTION COMPANY

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85% MAGNESIA HEAT INSULATION

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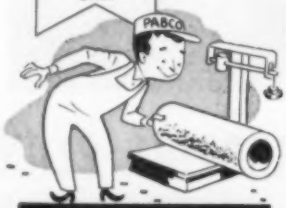
Modern engineering demands precise standards of heat insulation performance. Pabco *Precision Molded* 85% Magnesia combines the time-tested superiority of Magnesia with precision molding to give you a light weight insulation manufactured to very close tolerances.



Simpler and easier to apply! Easier to lift, cut and score. Simpler to imbed tie wires flush in the surface, too!

LIGHT WEIGHT

Pabco *Precision Molded* 85% Magnesia weighs just 11 lbs. per cubic foot. In addition to its light weight, it also brings many timely advantages, including easy application and greater rind strength.

CLOSE TOLERANCES

Pabco's plus tolerance is only ½ *lb. per cubic foot!* This means an amazing degree of control over such factors as Weight and Thermal conductivity. Other controlled factors include size, thickness and uniform fibre distribution.

Precision pipe fit! Both pipe coverings and blocks are molded to exact final size and thickness, not molded oversize and then "milled" to size.

THE DEPENDABLE STANDARD — "MODERNIZED"

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PABCO PRODUCTS INC.

INSULATION DIVISION

San Francisco 19 New York 16

Manufacturers of Heat Insulation Since 1920

PABCO ENGINEERING SERVICE UNITS IN ALL PRINCIPAL CITIES

pany, Inc. Simmons joins Alloy Steel Products after spending the past three years in various sales capacities contacting major industries on the west coast. He is a graduate of Worchester Polytechnic Institute with a B.S. degree in chemistry.

Labline, Inc., To Manufacture Laboratory Apparatus, Equipment

Laboratory Industries, Inc. and Alexander I Newman, former executive vice president of Precision Scientific Company, have announced the formation of Labline, Inc. for the manufacture of laboratory apparatus, instruments and equipment. In addition to his administrative duties as president of the new corporation, Newman will devote special attention to new laboratory instrumentation. Arrangements are now being completed for manufacturing, research and development facilities. The company's line of products include laboratory clamps, apparatus, baths, ovens and laboratory furniture.

Newman

A. P. Green Promotes Minter To District Sales Manager

The A. P. Green Fire Brick Company has announced the appointment of James W. Minter as district sales manager of its new Birmingham, Ala., office. Minter has been connected with the Green Company since 1941. Prior to his present appointment, he was in charge of sales at the company's Chattanooga office. Before joining the Green Company, he attended the University of Missouri.

Minter

Marner, Ex Graver VP, Enters Storage Fabrication Field

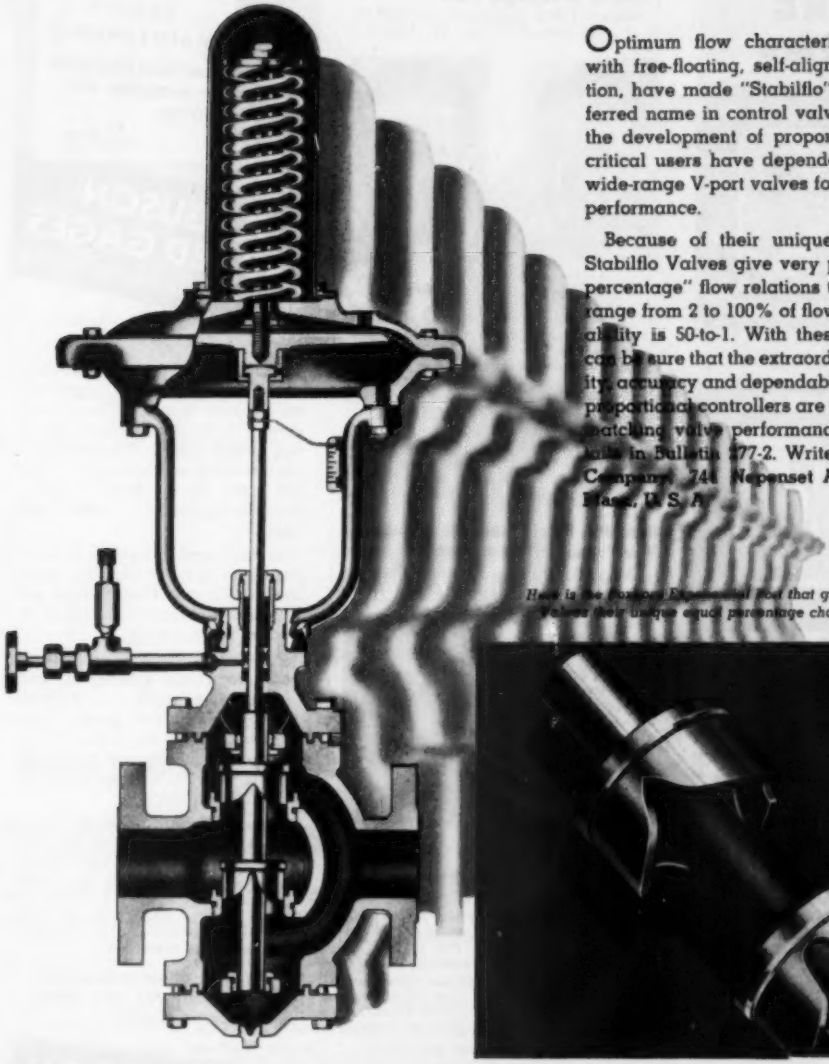
Charles L. Marner, formerly vice president in charge of sales for Graver Tank & Manufacturing Company, Inc., East Chicago, Ind., has announced that he intends entering the consulting field dealing with fabrication of petroleum storage facilities. He began his sales career with the original Graver organization in the early development of the petroleum industry, and is a recognized authority on problems relating to gasoline storage and the conservation of vapors from such storage.

Marner, who is on an extended vacation on his farm near Crown Point, Ind., said he would announce his definite plans as soon as they are fully developed.

Emerson Whitney Resigns As William Klemp Company President

Lee Shelley, president of the Shelley Steel Corporation, has announced the resignation of Emerson C. Whitney as president of the William F. Klemp Company, Whitney being no longer asso-

LET 60,000 INSTALLATIONS GUIDE YOU TO BETTER PROPORTIONAL CONTROL



Optimum flow characteristics, coupled with free-floating, self-aligning motor action, have made "Stabilflo" the most preferred name in control valves. Ever since the development of proportional control, critical users have depended upon these wide-range V-port valves for the utmost in performance.

Because of their unique port design, Stabilflo Valves give very precise "equal percentage" flow relations throughout the range from 2 to 100% of flow. Their rangeability is 50-to-1. With these valves, you can be sure that the extraordinary sensitivity, accuracy and dependability of modern proportional controllers are translated into matching valve performance. Get the details in Bulletin 277-2. Write **The Foxboro Company, 744 Neponset Ave., Foxboro, Mass., U. S. A.**

Here is the Foxboro Stabilflo Port that gives Stabilflo Valves their unique equal percentage characteristic.

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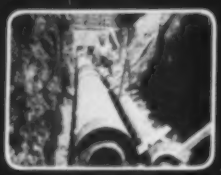
STABILFLO CONTROL VALVES

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

For
TOP EFFICIENCY
INSULATED
PIPING
SYSTEMS



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OR
OVERHEAD

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BEST CHOICE

For distribution of steam or hot water, oils or process liquids, Ric-wiL Prefabricated Insulated Piping will provide your piping system with maximum sealed-in protection and efficiency.

Architects, engineers, and contractors have long recognized the reliability of Ric-wiL engineering and manufacturing of high-efficiency insulated piping—factors that insure long trouble-free life of industrial, commercial, and residential piping systems.

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CLEVELAND, OHIO

Ric-wiL
PREFABRICATED
INSULATED PIPING
UNDERGROUND
OR OVERHEAD

ciated with the Klemp operations or interests.

The Shelley Steel Corporation bought the William F. Klemp Company in November, 1951. Shelley has been elected president of the Klemp Metal Grating Corporation which is the new name of the former William F. Klemp Company.

Niagara Filter Names Johnston, Trumpler to Enlarged Staff

Niagara Filter Corporation of Buffalo, N. Y., has named Arthur W. Johnston

Trumpler

Johnston

as sales manager and Alfred L. Trumpler as advertising manager and assistant sales manager.

Johnston was formerly with the Buflovak Division of Blaw-Knox Company and prior to that was with Worthington Pump and Machinery Corporation.

Trumpler returns to his former post as ad manager at Niagara after a year with Bell Aircraft Corporation. Both appointments are part of a new program of expansion planned by the Buffalo firm.

Ratcliffe, Baroid Manager, Named Vice President National Lead

George L. Ratcliffe, recently elected a vice-president of National Lead Company, has been a member of the board of directors since 1948.

Ratcliffe

Ratcliffe was graduated from the Carnegie Institute of Technology as an electrical engineer and joined National Lead in 1929. At that time he was president and general manager of the California Talc Company, one of the predecessor companies to the present Baroid Sales Division. Prior to the organization of California Talc, Ratcliffe saw service with Standard Oil Company (N.J.), Texas Pacific Coal and Oil Company and the General Petroleum Corporation. He has been general manager of the Baroid Sales Division since company operations under that name were begun in 1939. Baroid moved from Los Angeles to a new headquarters building in Houston last year.

Vapor Recovery Systems Designates New Sales Agencies

The Vapor Recovery Systems Company, manufacturers of "VAREC" tank equipment, gas control and safety devices has announced the appointment of two new sales agencies in the Tulsa and Minneapolis areas. The Tulsa agency, Arduser & Company, will service the Oklahoma and northeastern Texas area,

YOU'LL lick your cold weather gage problems . . . and cut maintenance hours and costs way down . . . when you install Jerguson Heated Gages. You eliminate gage freezing and breakage, or you can speed up the flow of heavy, sluggish liquids . . . with these gages.

You don't need to insulate, or wrap the gages with tubing, for these modern Jerguson Heated Gages are a completely fabricated unit with built-in steam tracing.

Jerguson Heated Gages are built in both internal tube (illustrated) and external tube models . . . in either reflex or transparent gages. They are available for the pressures you require, in a multitude of sizes, with tapped, flanged, welding socket or other connections.

Jerguson Steam Jacketed Angle Valves, #93 (and #93-U for close hook-ups), used with these heated gages, are available with ball check when required.

Both the gages and valves are available in special materials.

Write us about your problems. Send for new Data on Heated Gages.

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"Give it the air..."

now means...cool or condense the FIN-FAN way

AIR . . . not water . . . does the cooling or condensing in a Fin-Fan Heat Exchanger.

That means freedom from all water system complications, expenses, and troubles.

But that's only one of the many Fin-Fan benefits. With Fin-Fan, you get the superior heat transfer of the exclusive K-Fin helical cooling elements that have eleven times the external surface of the same length of bare tubes, you get a unit that can be built to withstand pressures up to 5000 psi and temperatures up to 1500F, and you can handle several different duties in a single installation.

This "package type" unit may be placed in any convenient location, operates independently of wind velocity and direction, and is simple and economical to operate and maintain.

Fin-Fan, developed jointly by Griscom-Russell and Fluor Corporation, Ltd., is widely used for practically every condensing and cooling service. Investigate Fin-Fan possibilities for your plant. Write for full information without obligation.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GR-247

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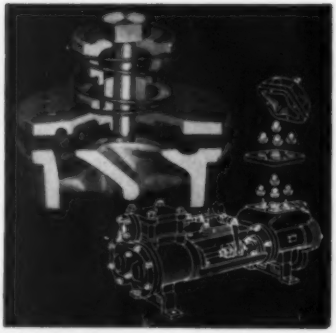
PIONEERS IN HEAT TRANSFER APPARATUS

HOW TO *Improve* PUMP PERFORMANCE *and Cut Costs*



Install Sims Pump Valves in your pumps and

(1) **Prevent stem and spring breakage.** Exclusive double shock absorber built into Sims Valves stops opening impact damage.

(2) **Stop wear.** Long guide of rotator prevents cocking of disc and assures even opening.

(3) **Keep seating surfaces leak free.** Sims guarantees the valve disc will rotate . . . and without mechanical friction . . . every time it lifts. It's cushioned top and bottom by liquid while it rotates. Wears uniformly all the way around.

(4) **Stop valve slam and knock.** Quiet operation is gained by cushioning moving parts and cutting resistance to flow through the seat, with patented inclined ribs. Reduced resistance means increased pump capacity—a 20% increase.

SIMS PUMP VALVE CO., INC.

WRITE FOR NEW CATALOG
New spiral bound catalog shows how they fit your pump . . . with efficiency and comparison charts. Send for free copy today.

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BLAW-KNOX GRATING

Electroforged into rigid, one-piece panels.

Twisted cross bar prevents slipping.

. . . GIVES BETTER SERVICE ON 5 COUNTS

1 SAFER FOOTING
2 GREATER STRENGTH
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5 MORE OPEN SPACE

Bring your open steel flooring problems to Blaw-Knox for expert help. Bulletin 2365 sent on request.

Grating Department
BLAW-KNOX DIVISION of Blaw-Knox Company
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BLAW-KNOX *Electroforged* STEEL GRATING

Kansas and Nebraska. The Minneapolis agency of the Paul B. Mueller Company will serve North Dakota, South Dakota, Minnesota and western Wisconsin.

Oliver United Filters Names Hoxie Western Sales Manager

Oliver United Filters Inc., manufacturer of industrial filters, pumps and allied equipment, has appointed James B. Hoxie as Western Division sales manager, with headquarters in Oakland, Calif. His territory takes in the mountain and west coast states. Hoxie, who has been with the company for 20 years, succeeds Philip J. McGuire who has been appointed director of Research and Development. Hoxie has spent 10 years in the company's Central Sales Division territory, working out of Chicago, and 10 years in the factories.

Hoxie

Sealol Elevates Justus Stevens To Vice President Capacity

Justus B. Stevens, a member of the Sealol Corporation for over 11 years, has been appointed vice president and chief engineer of the company, with headquarters in Providence, R. I. An engineering graduate of Brown University, Stevens first served Sealol as a draftsman-engineer. He was recently responsible for the design and development of mechanical rotary shaft seals, and has assisted in the application of Sealol seals in many types of products.

Kenneth Bell has been appointed assistant chief engineer.

Stevens

Bailey Meter Appoints Powell Manager of Buffalo Office

Bailey Meter Company, Cleveland, has appointed W. Powell, Jr. manager of the branch office in Buffalo, N. Y.

A graduate mechanical engineer, Powell is an alumnus of Penn State College, and is a veteran of 24 years with Bailey Meter Company. He has been handling the sales and service work of automatic combustion and process control equipment in Philadelphia and western Pennsylvania. As manager at Buffalo, he will be assisted by H. E. Bitler, J. R. Brennan, and Roy D. Kelley; and in the Syracuse subdivision by John I. Taylor and N. D. Jones.

Powell succeeds H. T. Sawyer, who has resigned to accept a position with RCA.

Powell

Kaylo Division Establishes New Regional Sales Offices

The Owens-Illinois Glass Company's Kaylo Division has reorganized its in-

Sears

Scott

sulation sales force establishing three regional supervisors who will direct insulation sales in their areas. Under them are five new branch managers handling the sale of all Kaylo products. The regional supervisors will report directly to Aubrey V. Baber, the division's manager of insulation sales.

Long

Until now most of this work was directed out of the Toledo office through sales engineers in the territories.

Those promoted to regional sales supervisors are Thomas F. Sears of Bowling Green, Ohio, who will direct insulation sales in southwestern United States from offices in Houston, Lewis F. Scott, who will cover the midwest from Chicago; and Robert L. Long of Maumee, Ohio, who will cover the east from the main office in Toledo

Those promoted to branch managers are Arthur B. Pike, former sales engineer in Boston who will head the office there; Carl Ramien, former sales engineer in Atlanta now on special assignment in Toledo who will head the Philadelphia office, which will be expanded to include the Washington, D.C. territory; Robert L. Major, sales engineer to manager in Pittsburgh; Ike Keith, sales engineer to manager in St. Louis; and James D. Hailey, sales engineer to manager in Cleveland.

David Innes was the first branch manager named and was assigned to New York last June.

Power Specialty Company Named Subway Grating Representative

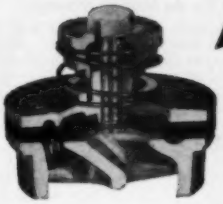
The Power Specialty Company, Inc., of Houston, has been named by the Irving Subway Grating Company at the exclusive Texas Gulf Coast area representative. They will handle sales and servicing of stock for engineered open steel flooring.

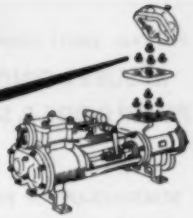
Richard W. Dalzell Promoted By Lukens Steel Company

Richard W. Dalzell, manager of commercial research at Lukens Steel Company, has been promoted to the position of assistant manager of market development. Dalzell, a native of Philadelphia, joined Lukens in 1946 as manager of

REDUCE PUMP REPAIRS

4 WAYS





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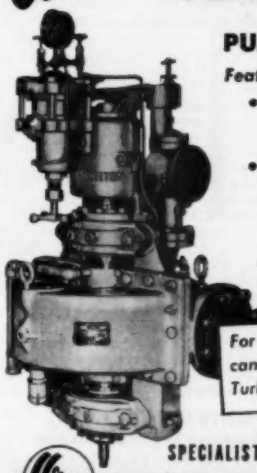

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See page 252 in the Refinery Catalog.

CHICAGO-WILCOX Mfg. Co.

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Chicago 19, Illinois

the commercial research department. Previously he had been associated with Stewart, Dougall & Associates. He was graduated from the Wharton School of Accounts and Finance of the University of Philadelphia.

J. R. Macon Named By Atlantic Refining Co. As Market Manager

The Atlantic Refining Company has announced the appointment of James Ralph Macon as market and product development manager of chemical product sales. A graduate of Emory University, Macon was employed by Pennsylvania Salt Manufacturing Company before joining Atlantic. He is a member of the American Ordnance Association and the American Society for Metals.

Ralph Carothers Named by B & W As Tubular Products Inspector

Ralph J. Carothers has been named chief inspector at the Beaver Falls plant of The Tubular Products Division, The Babcock & Wilcox Company. Carothers, a resident of Koppel, Pa., has been with the company's Inspection Department at Beaver Falls since 1929. He succeeds James A. DeBee who died recently as a result of an automobile accident.

Klemp Company, Chicago, Expands

A 50 percent expansion program was completed recently when the William F. Klemp Company announced the conclusion of a $300,000 project which included additions to its Chicago plant. Further expansion in 1952 will total $500,000.

LATEST DEVELOPMENTS in air conditioning and lighting systems were incorporated into the design of the recently completed Fluor Corporation engineering and drafting office in East Los Angeles. Walls of the building were precast, troweled smooth and lifted into place; columns were poured between the exterior wall panels as integral parts of the structural frame, resulting in a well-tied concrete structure. This basic design made it possible to construct the building without disturbing existing work functions in the adjacent Fluor building. William J. Moran Company was the consulting engineer and general contractor for this structure which includes 9600 square feet of floor area.

Thomas Heads New Chiksan Sales Development Department

Chiksan Company has created a new Sales Development Department and appointed E. Nelmes Thomas, former assistant manager of the Sales Promotion Division of Commercial Solvents Corporation, manager. Thomas will make his headquarters at the main Chiksan plant in Brea, Calif. Expanding sales promotion activities for the company caused the necessity of establishing the new department. Among the department's major functions will be the handling of advertising and sales promotion programs, sales analysis and market research.

Thomas

Insul-Mastic Makes H. P. Berry New Southern Regional Manager

Henry P. Berry has been named southern regional manager for the Insul-Mastic Corporation of America. He will make his headquarters in New Orleans. He was formerly an assistant to the chief insulation engineer of the Carbide & Carbon Chemicals Corporation where he worked out specifications for thermal insulation and tested coatings for vaporsealing such insulation. Berry is a native of Huntington, W. Va.

Blaw-Knox Announce Appointment Of Levison as Vice President

Blaw-Knox Company has announced the appointment of Arthur A. Levison as vice president and general sales manager of its Blaw-Knox division. In this position, Levison will administer the sales and engineering functions for all departments of this division. It was also announced that H. Russell Loxterman

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Western Steel Prod. Co., 1735 W. 13th Ave., Denver 4, Colo.

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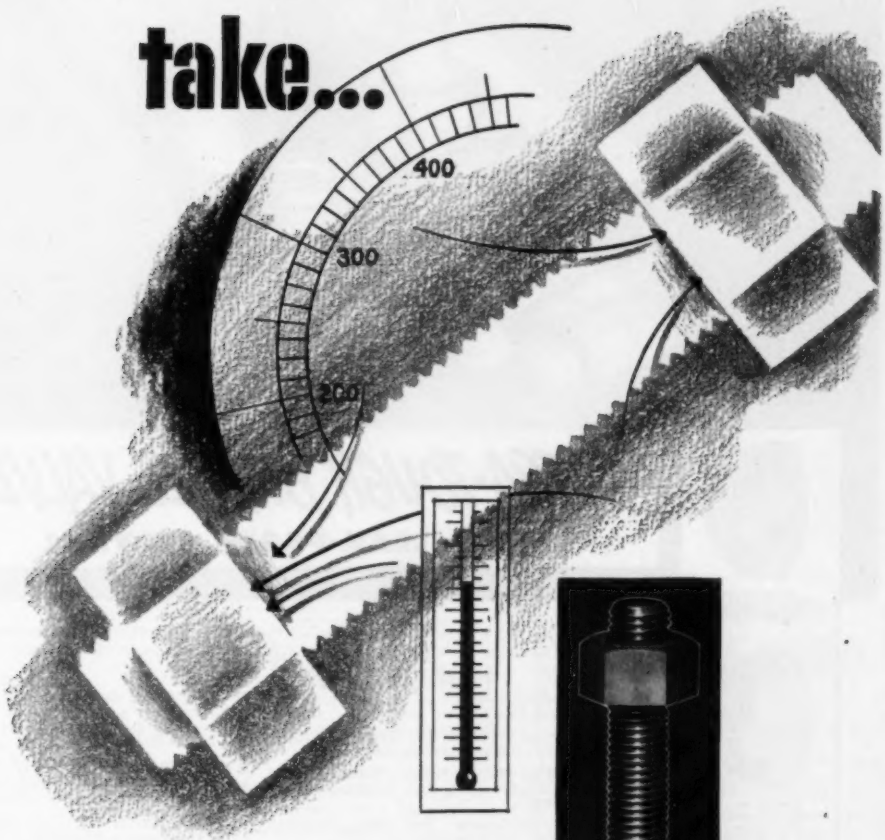

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. . . are designed to withstand high pressures and high temperatures longer. They're made from high-strength steel alloys. Threads are accurate and uniform to provide full engaged-thread area for maximum strength under all conditions.

Specify Republic Upson Alloy Steel Studs . . . they fit-up tight, stay strong even under tough working conditions.

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EXTRA-TOUGH BRONZE VALVES

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When you buy bronze valves, get what you want – greatest efficiency, longest service, biggest savings. Extra-tough Hancock Bronze Valves assure *all three* with features like these:

- ✓ "500 Brinell" Stainless Steel Plug Seat and Disc prevent leaks.
- ✓ 125% to 230% Stronger Diaphragm than ordinary bronze valves.
- ✓ Hard-Rolled Bronze Stem (Acme threads) takes the roughest treatment.
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- ✓ Rigid Body, Bonnet and Bonnet Ring of durable steam bronze withstand installation and service abuse.
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Durable Hancock Bronze Valves are made in sizes from ¼" through 2" – globe and angle types, screwed ends — for 150#, 200# and 300# W.S.P. ratings. Phone your nearby Hancock Distributor for prompt delivery. Remember, Hancocks cost no more than ordinary bronze valves.

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This man must be capable of handling a complete job, customer contacts, supervision of layouts and design, selection of equipment and supervising other personnel assigned to a Project.

In applying furnish a complete detailed resume of your experience, background, education, availability and a recent snapshot or photograph.

Salary commensurate with ability.

Write Box 116-R, c/o Petroleum Refiner, P. O. Box 2608, Houston, Texas.

has been appointed assistant general sales manager of the division. In addition to his new duties, Loxterman will continue as manager of the steel plant equipment department.

Bauer Appointed Worthington Purchasing Agent at Oil City

B. A. Bauer has been appointed purchasing agent and supervisor of stores of the Oil City, Pa., plant of Worthington Pump and Machinery Corporation. Bauer, a native of Oil City, was employed by the National Transit Pump and Machine Company for 30 years previous to Worthington's acquisition of the plant. During the period with National Transit he served in various capacities, among which were 16 years as purchasing agent, and three years as secretary and assistant treasurer.

Oilwell Names D. Wohlford Snyder, Texas, Store Manager

D. L. Wohlford has been named manager of the Oil Well Supply Division of the U. S. Steel Company at Snyder, Texas, being promoted from field sales representative in that city. Wohlford joined "Oilwell" in 1949 as a storeman at El Dorado, Ark., and was transferred to Snyder in a similar capacity in 1950. He is a graduate of Texas A. & M. College in business administration.

Ansul Chemical Expands Sales

Because of increased business in the Detroit and Milwaukee areas, the fire extenguisher division of Ansul Chemical Company, of Marinette, Wis., has transferred its district offices in those cities to new and larger quarters. The new Detroit office will be located at 17184 Wyoming, Detroit 21, and the new Milwaukee quarters at 2755 N. Third St., Milwaukee 12.

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RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Display ads,** set in suitably larger type with ruled border, $10 per column inch.

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Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.

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Wanted: CHIEF ENGINEER, preferably one who has had at least six or more years in Refining with some asphalt and processing engineering experience to take charge of maintenance and new construction, location Northeast Texas. Box No. 111-R, Petroleum Refiner, Houston, Texas.

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with two to four years' experience in gasoline treating for technical service with large chemical company selling to the petroleum industry. Position involves considerable traveling in East and Middlewest. Please include details of education and professional experience, as well as a recent photograph, in first letter. Box 106-R, c/o Petroleum Refiner, Houston, Texas.

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California engineering company has responsible permanent staff positions open to graduate chemical engineers with broad experience on design of condensers, stills, absorption towers and related petroleum refinery and chemical plant equipment.

Write giving full details, references, salary requirements. Your reply will be held confidential.

Our organization knows of this ad. Box 117-R, c/o Petroleum Refiner, P. O. Box 2608, Houston, Texas.

Named Childers Sales Manager

Childers Manufacturing Company, Houston, has appointed John F. Templeton to handle sales of aluminum pipe jacketing in Georgia, Alabama, and north Florida. Templeton's headquarters are located at 901 William Oliver Building, Atlanta. He previously was engaged in consulting and design work on power plant problems for more than 15 years.

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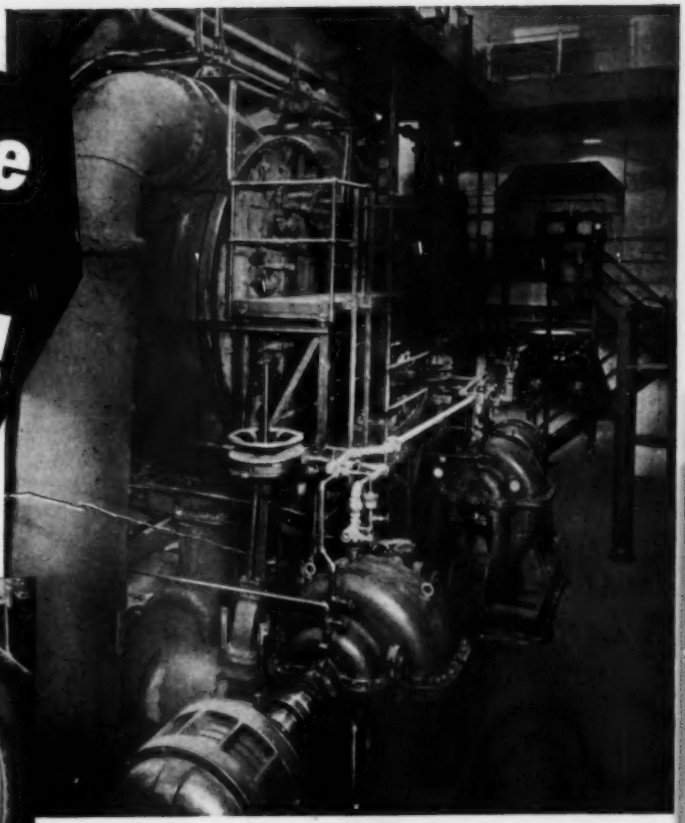
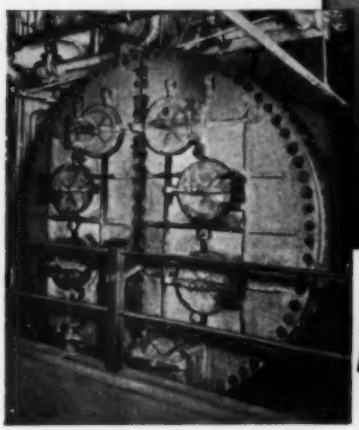
Before you SCRAP!



Condenser of the Lynn Gas & Electric Co., Lynn, Mass., which was returned to service by use of inlet-end inserts at a saving of $30,000.



Before you scrap condenser tubes because of inlet-end leaks

GET ALL THE FACTS

It sometimes happens that a combination of erosion and corrosion at the inlet ends of condenser tubes may seem to force their replacement. This is not always necessary. If the damage is confined to a small area at the inlets, and the tubes otherwise are in good condition, they can be saved by using inserts designed especially for just such circumstances. There are several makes available, none made by Revere.

In a recent case, involving a condenser of the Lynn Gas & Electric Company, Revere recommended inserts. Here are the figures: Number of tubes involved, 4,100; Replacement cost, $35,000; Cost of inserts to cure the trouble, $5,000; Saving, $30,000. Repairs should enable the condenser to serve for several more years. The work was so successful that a similar job was done on another Lynn condenser containing 2,700 tubes.

Of course Revere wants to sell condenser tubes, and its other products in copper and copper-base alloys, and aluminum, but we know that fast friends and loyal customers are won by taking to heart the best interests of those with whom we deal. May we have the privilege of working with you on condenser tube matters?

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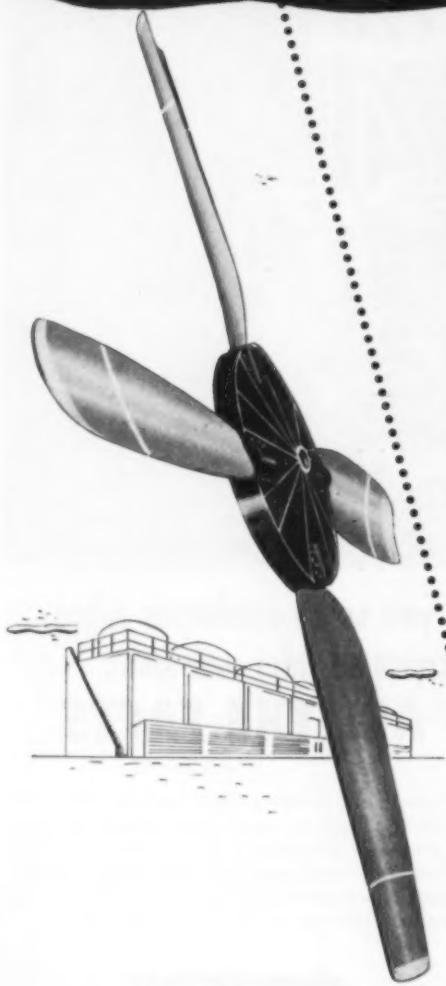
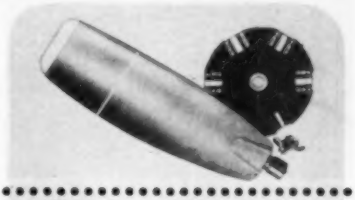
HARTZELL COOLING TOWER FANS

--dependability under the worst of weather and wear

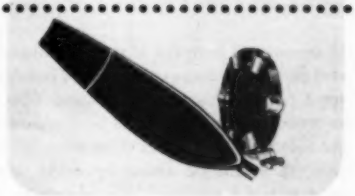


Corrosion, vibration, abrasion. These are the big headaches of the cooling tower fan operator. And these are the problems Hartzell engineers consider when they design cooling tower fans. The exclusive Hartzite plastic blade makes this fan practically impervious to acid and alkali corrosion and weathering; it greatly reduces the possibility of vibration damage. A plastic reinforcement at the base of each blade prevents concentration of flexing at the shank. And the rugged Hartzell hub packs tremendous strength—far beyond any calculable needs.

Sizes that range from 10 feet to 22 feet in diameter give the cooling tower operator the opportunity to select exactly the *right* type of fan for his installation. If you are in doubt as to the type of fan to use—call your Hartzell field engineer for the answer. Regardless of your location, there's one near you. Or, if you desire more information, write for the newly revised bulletin 1503 which gives the details about Hartzell cooling tower fans.



Blade and hub construction used on the 14 to 22 foot models.



Blade and hub construction used on the 10 to 13 foot models.

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Div. of Castle Hills Corp.
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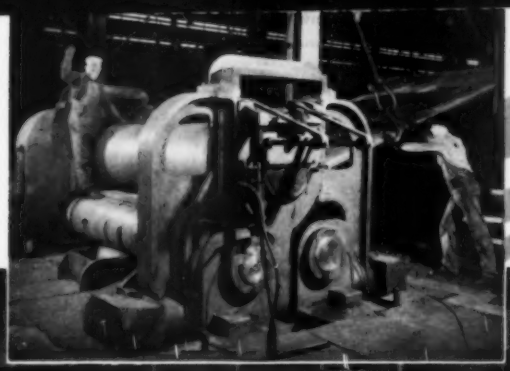

BIRTH OF A *150-TON* STEEL BABY

STEEL PLATE
FABRICATORS
AND ERECTORS
SINCE 1913

Wyatt's

HOUSTON · DALLAS · NEW YORK · TULSA

McDONALD *Swing Joints*

Plate 889—McDonald Standard Swing Joint (Straight). Iron body, bolted iron gland, bronze ferrule. Available in 1¼", 1½", 2", 2½", 3", and 4" sizes.

Plate 814—McDonald Standard Swing Joint (Double). ¾", 1", 1¼", 1½", 2", 2½", 3", 4", 6", 8", 10".

Recognized Throughout The World as TOPS in Design, Workmanship, Performance

Ever since we originated the Swing Joint years ago, we have concentrated on the objective of perfect performance . . . You'll find evidence of that policy in the many engineering advances that McDonald Swing Joints embody, in their precision manufacture, in their amazing ability to deliver years of trouble-free service, and in their worldwide reputation as the finest products of their kind. To look for the McDonald mark is such a sure and simple way to get more for your money.

A. Y. McDONALD MFG. CO.

"The Home of the Swing Joint"

DUBUQUE, IOWA

There's a McDonald Branch or Distributor Near You

Plate 984—McDonald Master Swing Joint (Double). Highest development of Swing Joint design. Grease-gun lubrication—all-brass construction — unbelievable ease of operation. 1½", 2", 2½", 3".

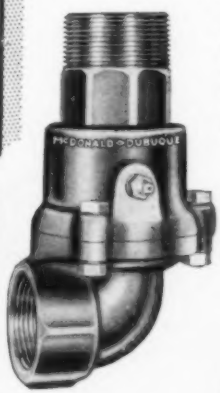

Plate 983 — McDonald Master Swing Joint (Single). A single ring is used for packing—replaceable, if required, in jiffy-quick time. 1½", 2", 2½", 3".

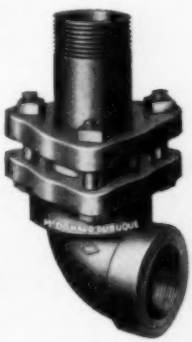

Plate 813 — McDonald Standard Swing Joint (Single). ¾", 1", 1¼", 1½", 2", 2½", 3", 4", 6", 8", 10".